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RADIO & ELECTRONIC COMPONENTS

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Technical articles will be gladly considered for publication, payment being made by arrangement. Articles should preferably be from 3,000 to 4,000 words, but no rigid limit is imposed. Manuscripts should be typewritten, in double spacing, on one side of the paper only. Diagrams may be drawn in pencil provided that they are clear and adequately lettered. For half-tone illustrations, glossy prints are preferable. While every care is taken of MSS. submitted, no responsibility can be accepted in case of loss.

CONTENTS

Commentary ... 643
Multiaperture Devices ... 645
By P. Broomer
Development of New Cardiac Pacemaker ... 648
Microphones—Part 2. Constructional Description ... 650
By G. R. Pontzen
Problems in the Manufacture of Mass-produced Precision Pressings. Part 2 ... 656
By J. Mortimer
Photomultiplier Tubes ... 659
Encapsulation Systems for Electronic Components ... 662
By M. C. Volk
Television Silver Jubilee ... 669
Pye Plan for Television ... 671
Transistors in Experimental Work. Part 3 ... 672
By F. M. Russell, Ph.D.
Improving Performance of Microwave Receivers ... 678
Transistors or Valves? ... 679
By G. F. Penver
Impact Extrusion of Transistor Bases ... 681
By J. S. Waite
Calibration of Waveguide Reflectors ... 683
Telcon Plastics Ltd. ... 684
Supplement to Buyers' Guide ... 685
New Components ... 687
New American Products ... 692
Manufacturers' Publications ... 694
Activities in the Industry ... 696
Personalities ... 699

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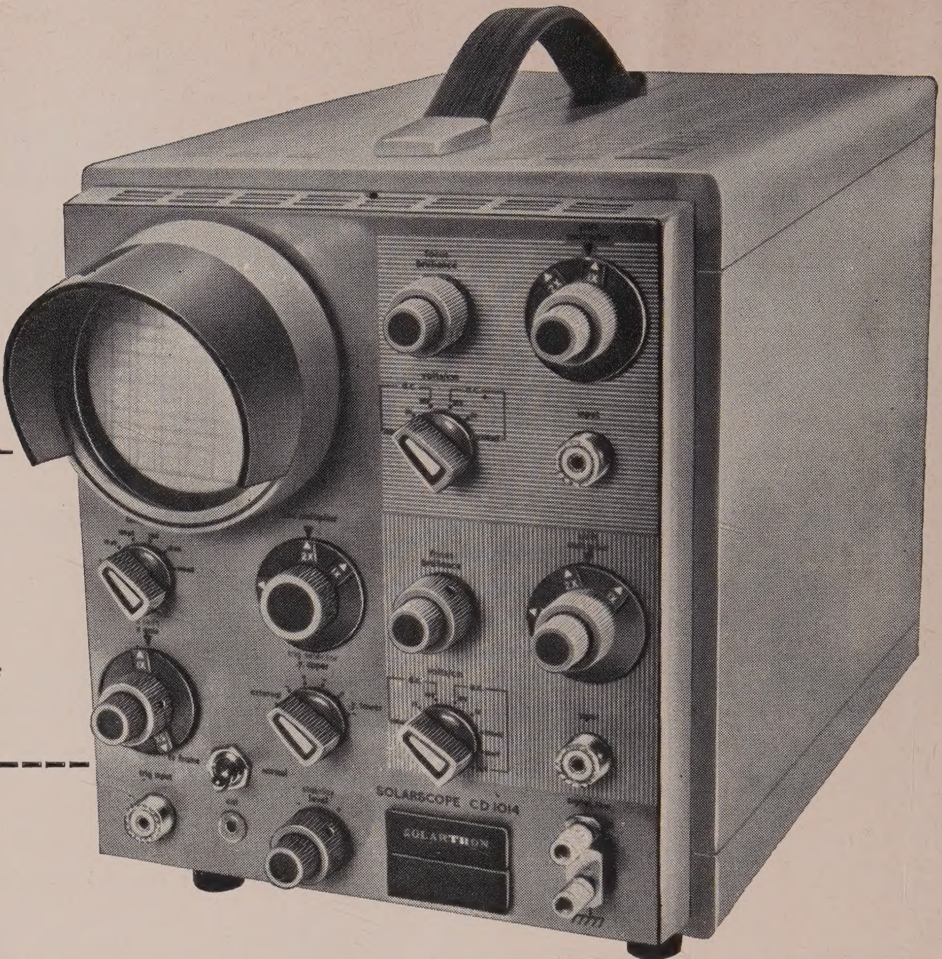

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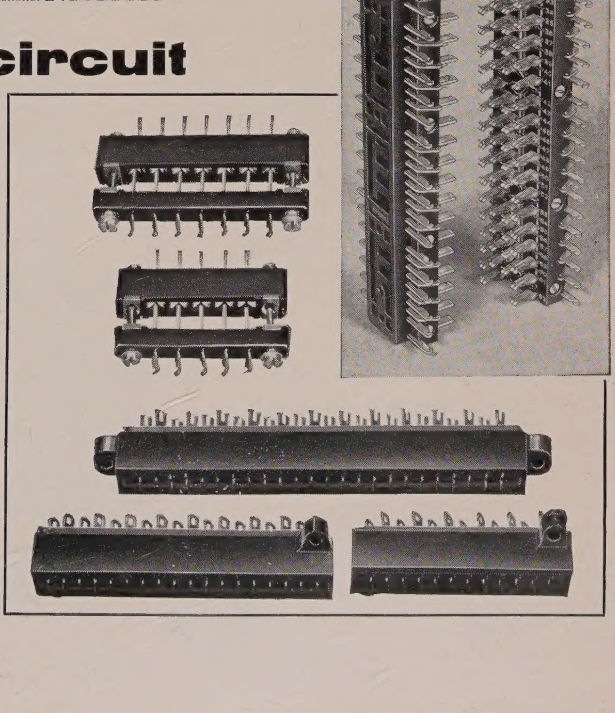

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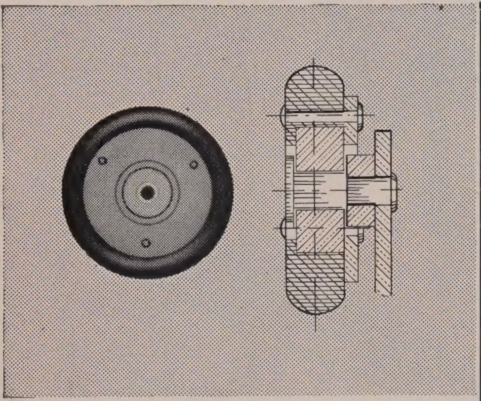

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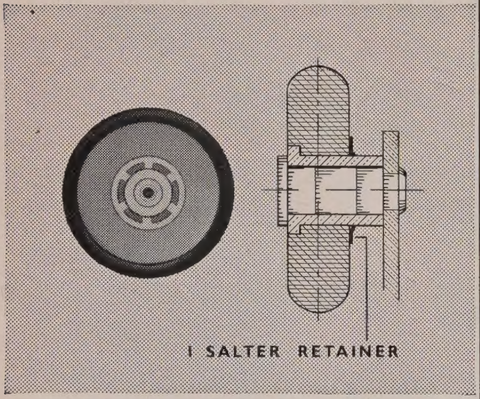

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inspection	·14
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	Peak Inverse Volts	Max. Forward Current	Min. Forward Current at 1V	Max. Reverse Current at P.I.V.	
HS1020	200	200 mA	200 mA	·020 μA	2 μA
HS1001	150	170 mA	100 mA	·050 μA	5 μA
HS1002	150	170 mA	100 mA	·100 μA	—
HS1003	150	170 mA	100 mA	·200 μA	—
HS1004	50	170 mA	100 mA	·050 μA	5 μA
HS1005	50	170 mA	100 mA	·100 μA	—
HS1006	50	170 mA	100 mA	·200 μA	—
HS1007	150	140 mA	50 mA	·050 μA	5 μA
HS1008	150	140 mA	50 mA	·100 μA	—
HS1009	150	140 mA	50 mA	·200 μA	—
HS1010	50	140 mA	50 mA	·050 μA	5 μA
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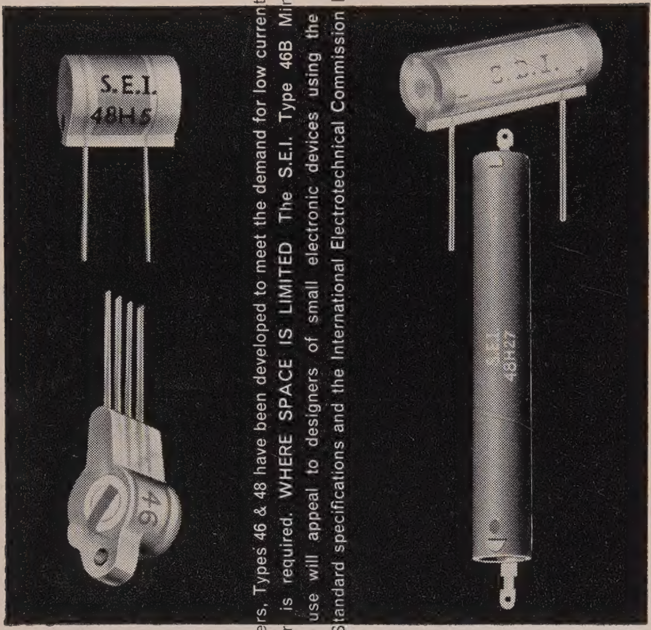

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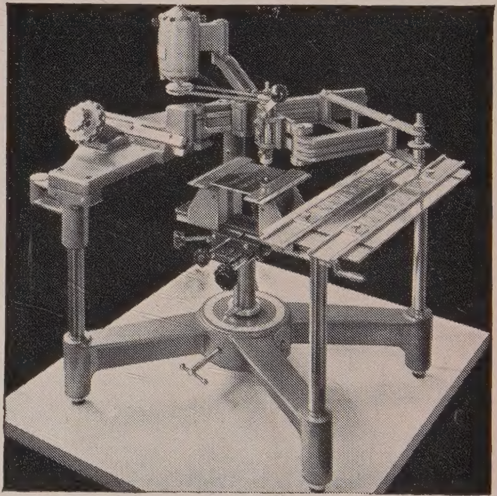

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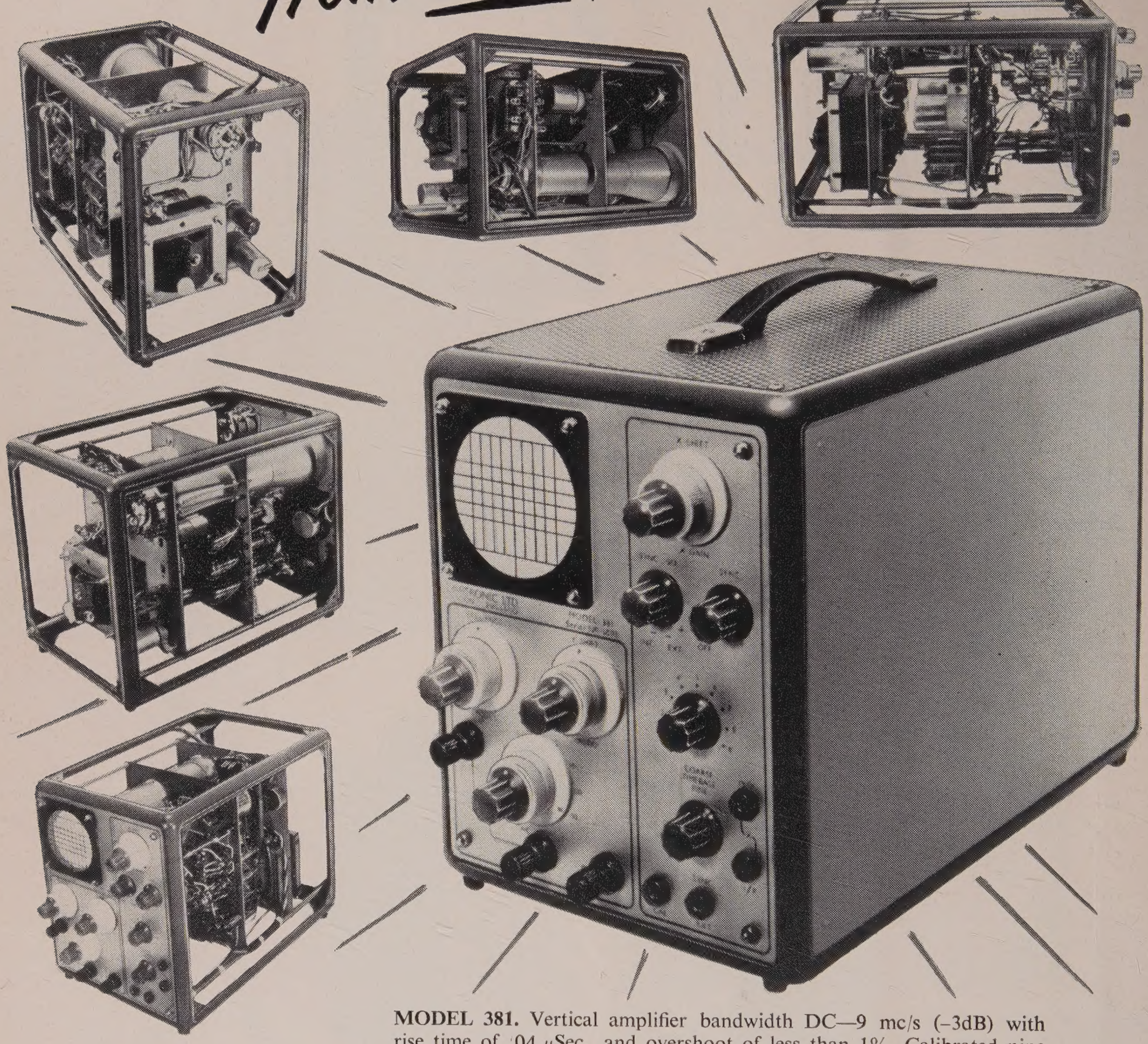

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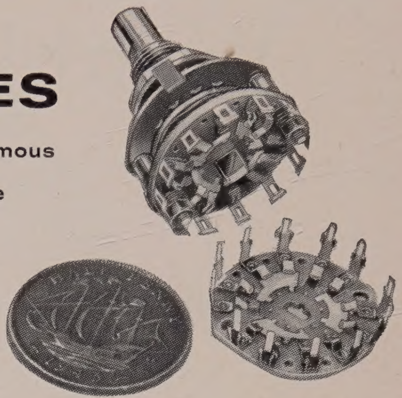

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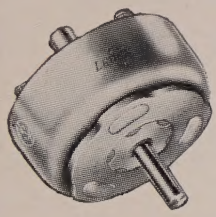

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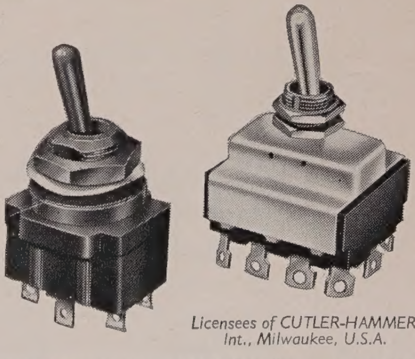

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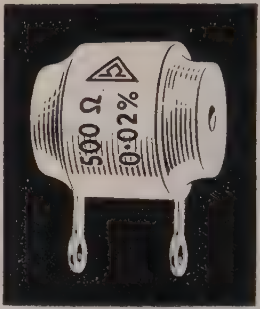

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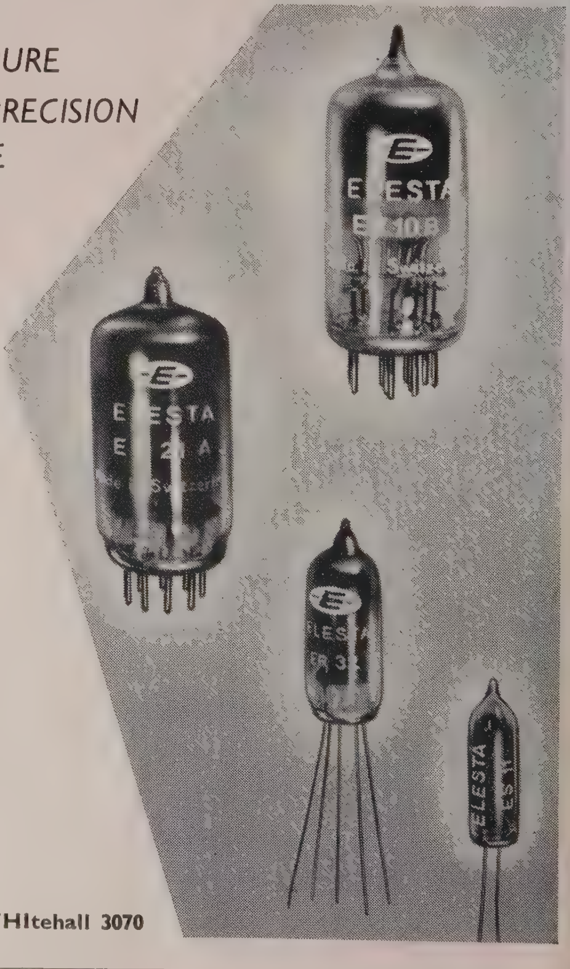

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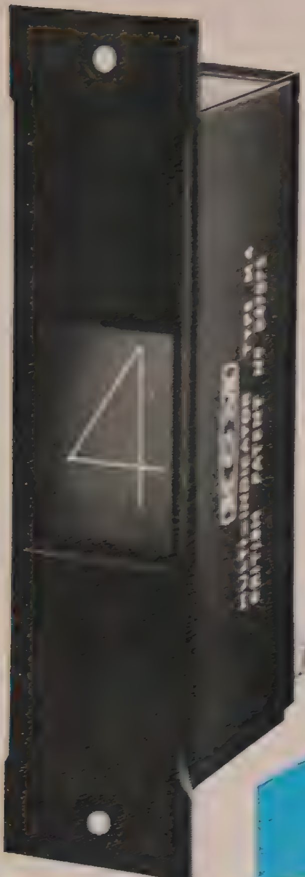
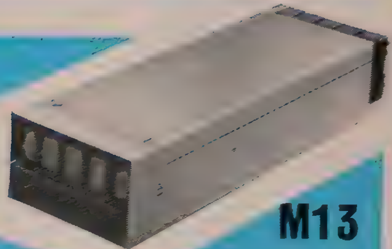


M3

K.G.M. MULTI-INDICATORS

M4

M9



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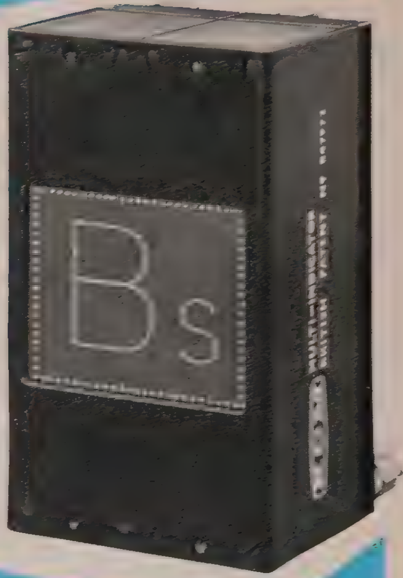

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TYPE HEL 07 — 10

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Independent Law Accuracy to closer limits.
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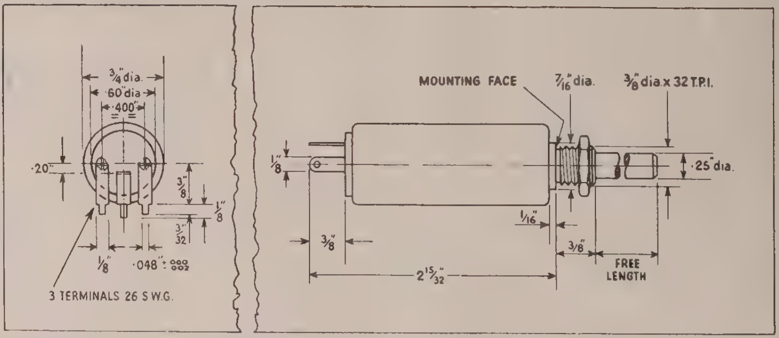

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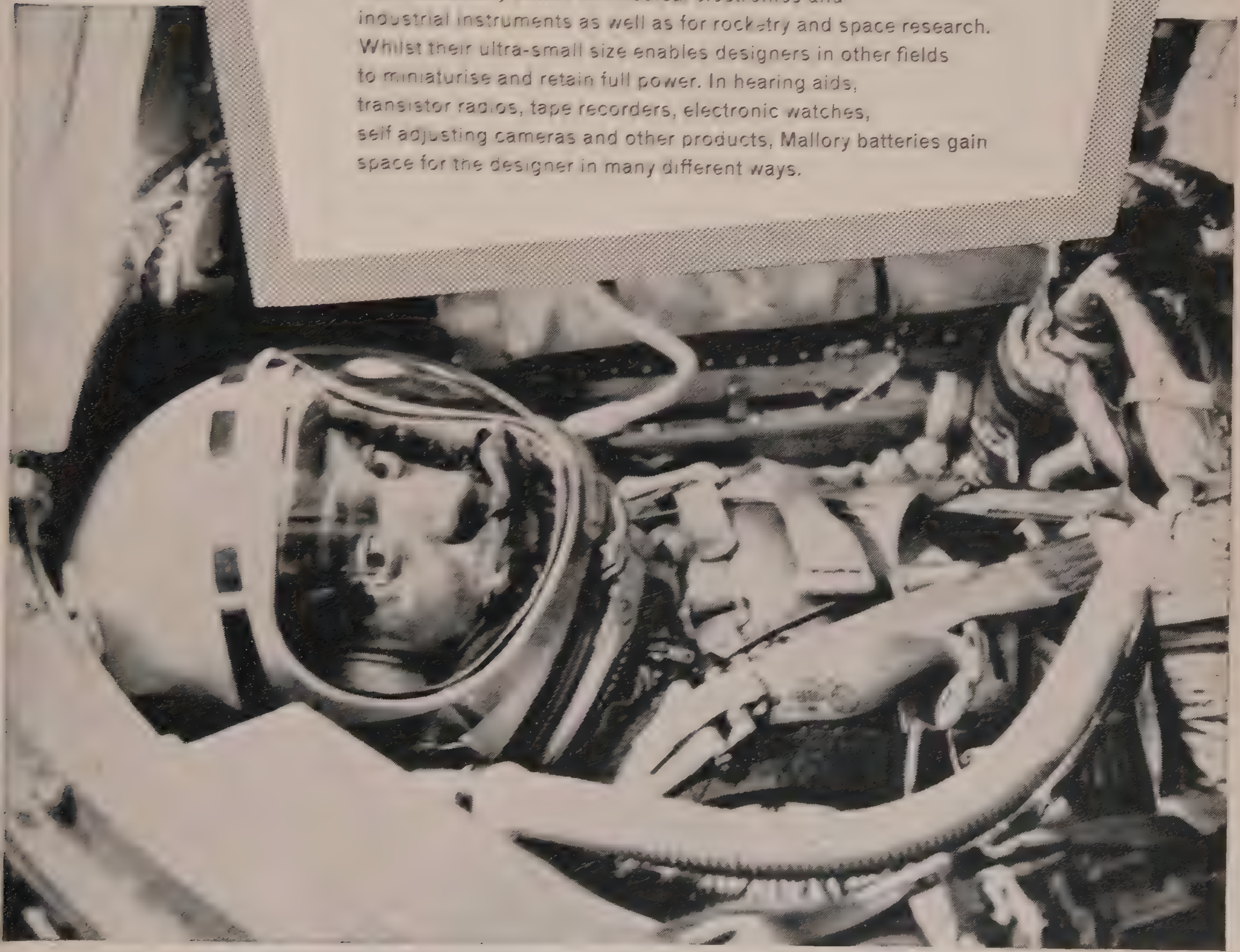

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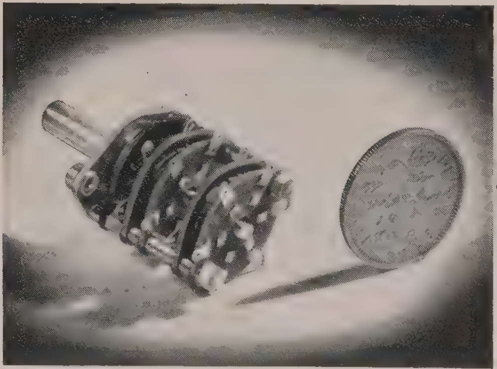

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REC **21** for further information

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- Silver Star ^(R) quality

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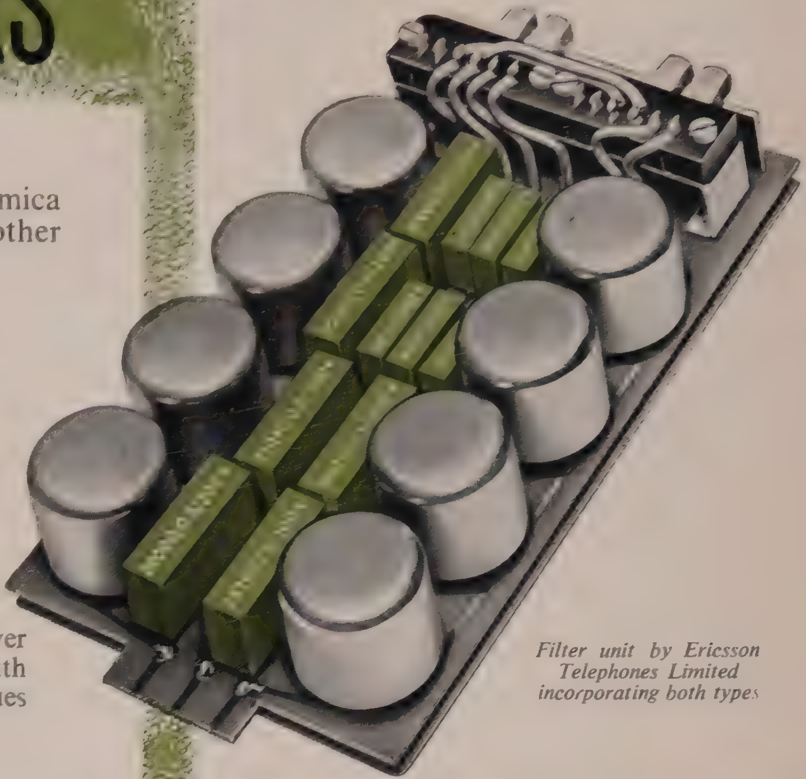

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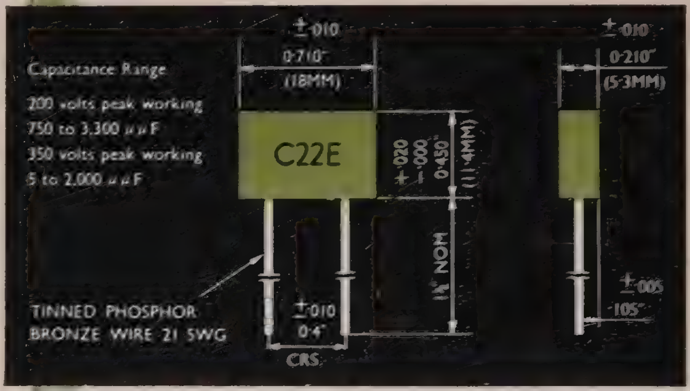

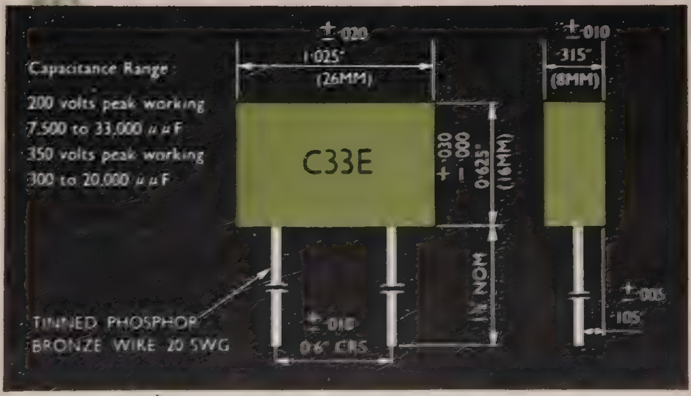

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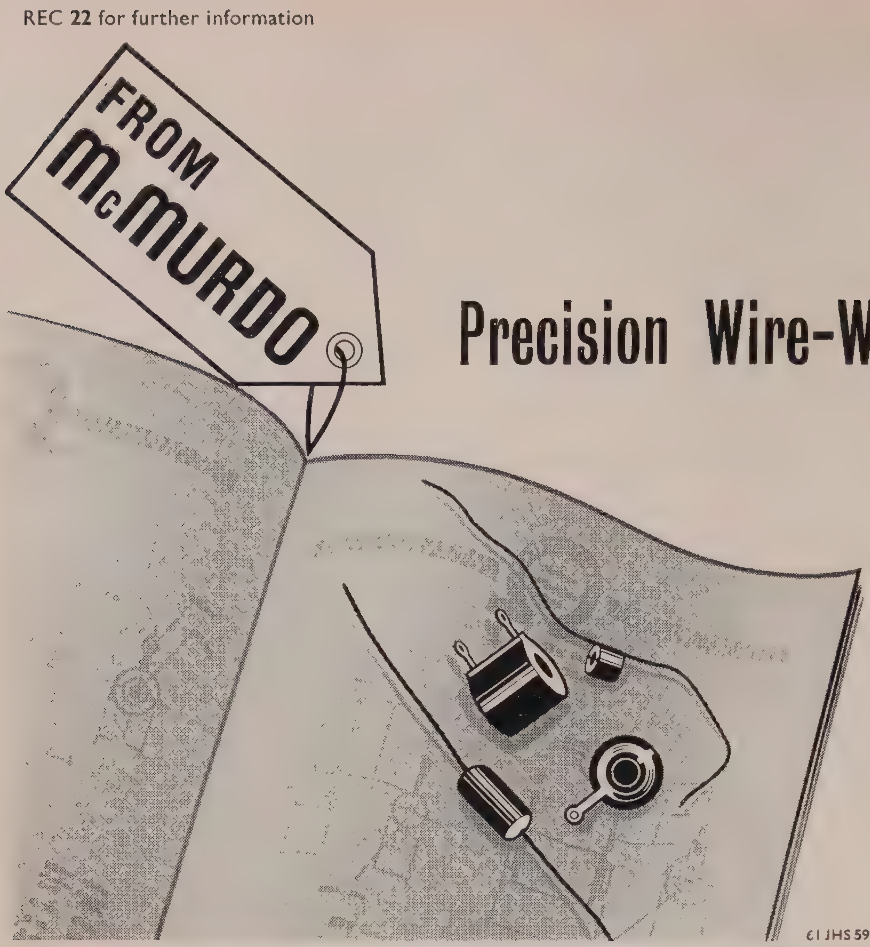

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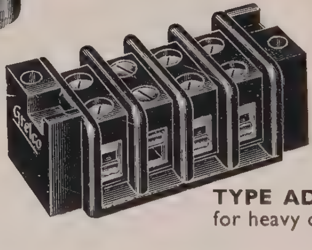

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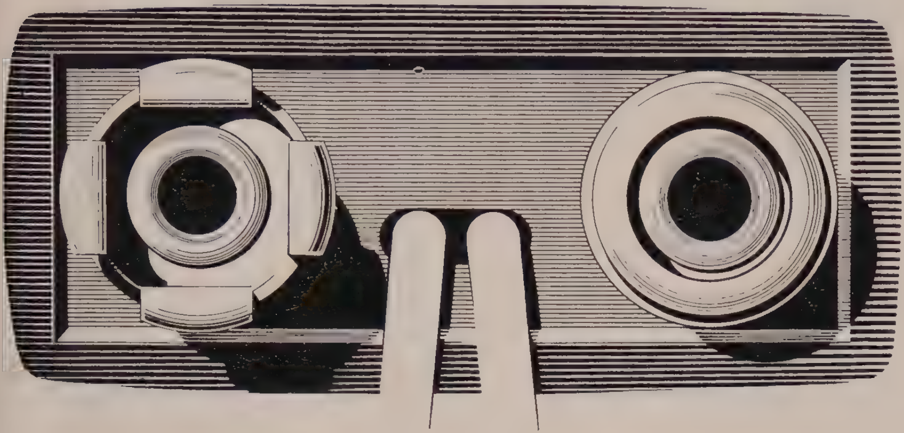

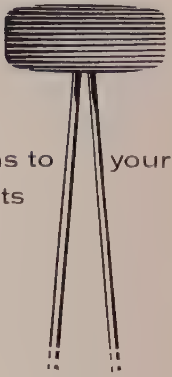

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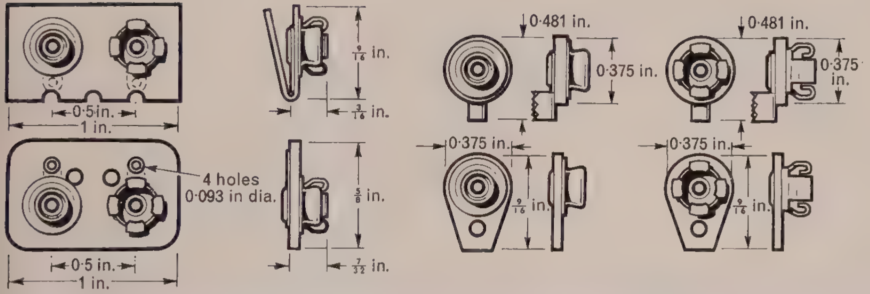

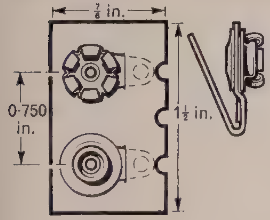

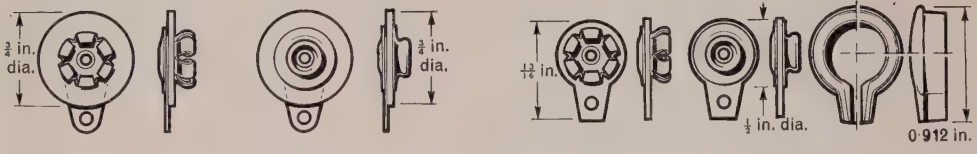

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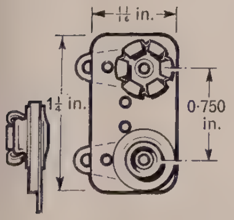

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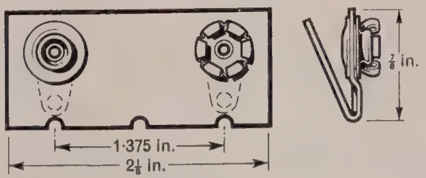

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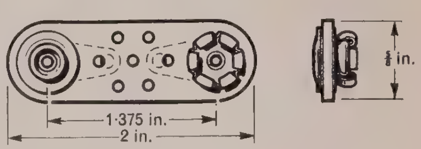

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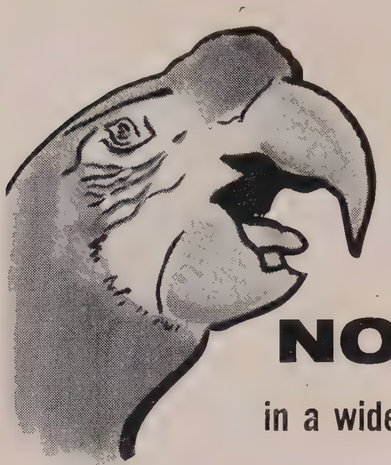

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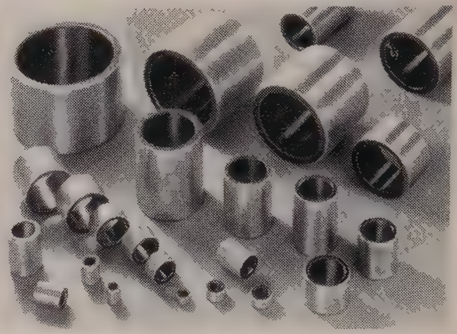

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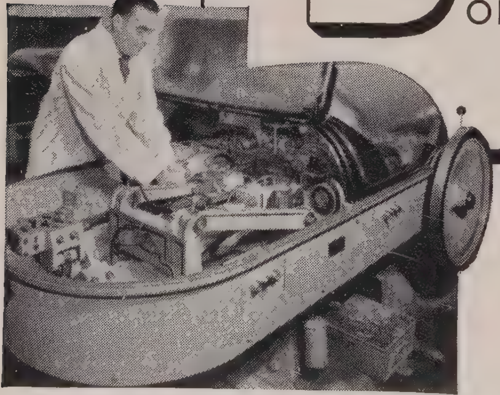

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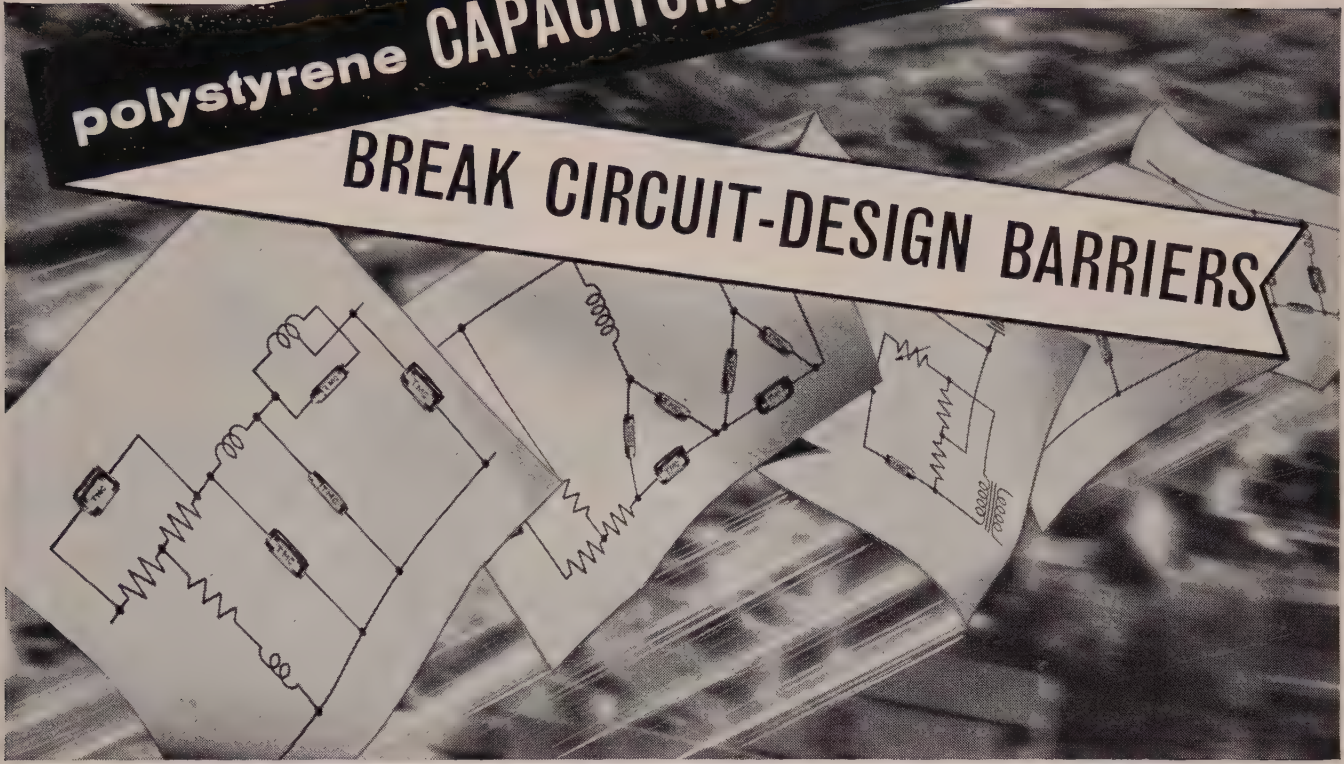

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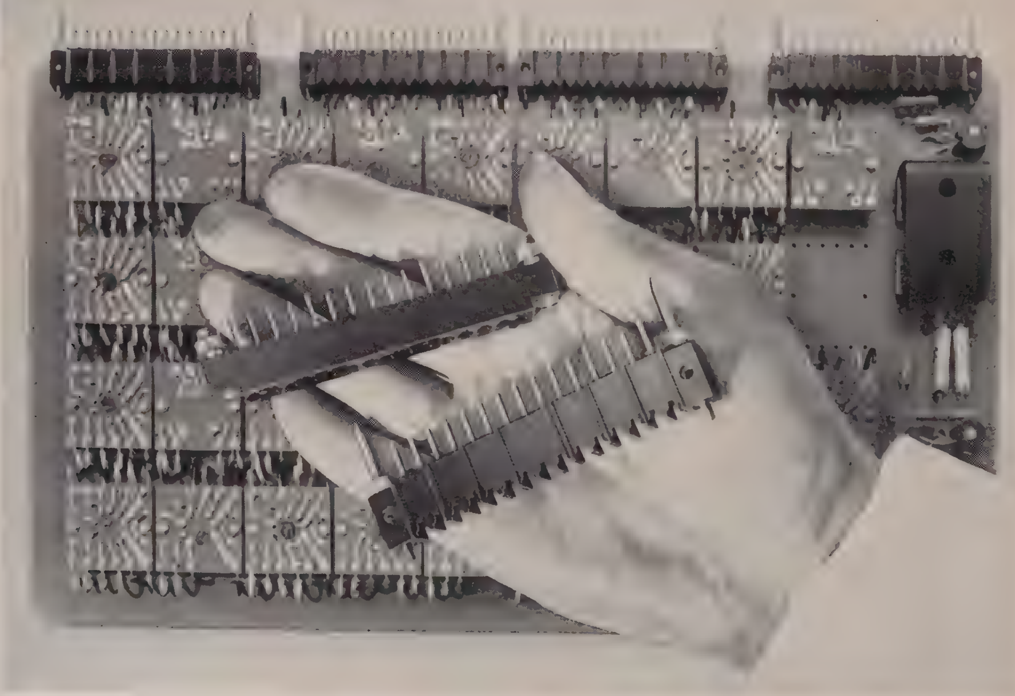

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Commentary

Export Assistance Register

IN THE July issue of *Radio & Electronic Components* we made a plea for more co-operation between companies in the electronics field in order to avoid wastage of effort and thus provide greater opportunities in the export markets. For this reason, we are delighted to note the publication of an "Export Assistance Register" by the Institute of Directors. This has been sent to the directors of more than 500 companies who have asked for guidance in their export activities.

The Register was compiled by the Institute's "Export Action Now" Committee from answers to a questionnaire sent to the Institute's 37,000 members asking if their companies needed help to begin selling overseas or, alternatively, were able and prepared to give it.

Listed in the Register are some 600 companies—manufacturing more than 500 different main categories of goods—who have offered export assistance to *non-competing* concerns. The two words in italics are worth notice because it is our hope that they will, in time, not be applicable to the Register. We would repeat once more that export is not now just a question of individual firms competing in overseas markets but more a question of British industry as a whole competing against the rest of the world. It seems obvious that firms in identical fields could be of more help to each other than if one produced goods entirely different to those of the other. This, however, is a difficult problem which only time can solve.

At the moment, there are only 15 entries under the heading "Electronic Apparatus". There are no entries under the heading "Electronic Instruments" but there are eight entries under the heading "Scientific Instruments". There is not a heading for "Electronic Components" and, although there are references made to a few specific types of component, there is no mention made of, for instance, semiconductors. The Register does, of course, cover a tremendous range of products but it is to be hoped that the emphasis on electronics will increase in future issues.

The companies listed have undertaken to give free export help and guidance of a purely general nature and specific propositions will be a matter for individual arrangement between the companies concerned.

The Register is set out in such a way that directors of firms seeking help can choose a "guide" company, either by product or location, or can approach a company with specialist experience of a particular territory overseas. The names of the firms who have asked for help will be kept confidential and it will be for them to select from the Register the company they think can most appropriately help them.

When the Institute has assessed results and additional offers of help it may well be decided to extend future editions outside its own membership to Industry as a whole. We would certainly support such a move but, in the meantime, copies of the first edition are available to interested Trade Associations on request to the Institute of Directors.

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MULTIAPERTURE DEVICES

A Survey of the Development of Multiaperture Ferrite Cores as Logic Units.

By P. BROOMER
Aircraft-Marine Products (Great Britain) Ltd.

IN THE last few years, a great deal of work has been proceeding in the U.S.A. on the development of multiaperture ferrite cores to work as logic units. The whole basis of the work comes about by the introduction of ferrite materials into the computer field. By the nature of these ferro- and ferri-magnetic materials, it is possible to manufacture multiaperture cores with desirable properties. The object behind the whole development is to make a computer system of logic elements, purely out of magnetic circuits. This will lead to simplicity, low cost, and extreme reliability of the device manufactured, and the applications of such units, as far as logic is concerned, are limitless; the only inherent draw-back is the fact that all magnetic materials are "lazy", thus, the speed at which a logic unit will operate is determined by the material used.

TYPE	EXAMPLE	CRYSTAL	"EASY" AXES
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Ferro	Fe	Cubic	3
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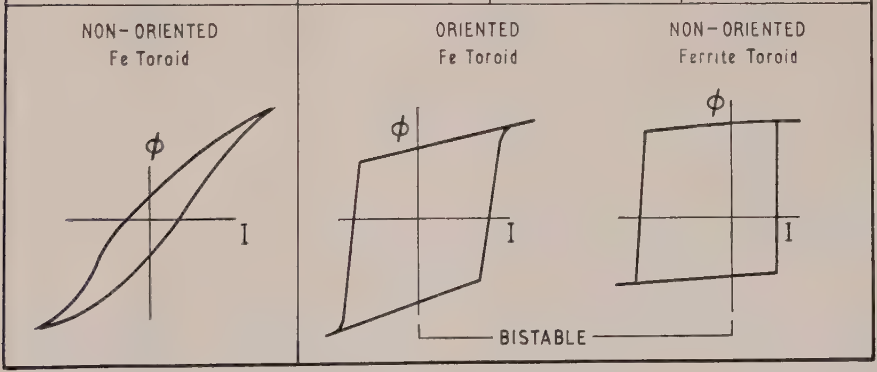


Fig. 1. BH loops.

Materials

In the first diagram can be seen the atomistic natures of the more common ferro-, ferri-, and anti-ferro-magnetic materials. It is apparent that, in ferro magnetism, the cubic crystal structure has three easy axes, one of the most common forms being iron, which gives the material six easy directions for the magnetic path. Now, if we are able, either magnetically or mechanically, to ensure that the crystal orientation in a soft iron toroid is in its correct radial condition, a square shaped BH loop would result. This is achieved in modern practice by transformer cores being wound with magnetic tape, usually Permalloy, and it is apparent that such a core could not be manufactured to form a multiaperture device although the BH loop might be satisfactory. Physically, the core would be impossible to manufacture and the multiplicity of magnetic paths would not, therefore, be available.

We now have to look to material which will give us the square loop we require, and the ability to be manufactured into correct shape. This brings to mind the ferri-magnetic materials, which are associated with spinal crystal structures, and, being octahedral, have twelve easy axes which give twenty-four magnetic paths. Thus, a toroid can be manufactured using the randomly orientated small crystal. An easy axis is bound to be within a solid angle of approximately 30° to any of the required directions and, consequently, any number of flux paths may be accommodated in the multiaperture device, all of which will have a square BH loop.

Description of the Device

Fig. 2 (*a*) shows the shape of a typical MAD (multiaperture device) core, the particular one shown having four minor apertures. For simplicity, the minor apertures are shown with an imaginary flux path indicated by an arrow.

In all logic systems, it is essential to have discrimination between the "0" and the "1" condition, this being the basis of the whole system. An example of this is a transistor which can be in the "on", the conducting, or in the "off" state.

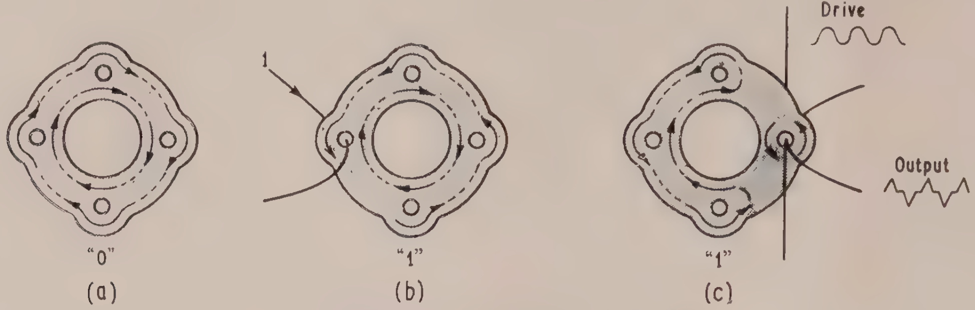


Fig. 2. Digital setting and non-destructive read-out.

The multiaperture device, shown in Fig. 2 (*a*) has all the flux in one direction (clockwise), this being the "0" condition. If a winding is looped into the left-hand minor aperture and a current passed through it, it will tend to switch the flux around the shortest closed magnetic path. This, however, is around the inside leg of the minor aperture which is already saturated in that direction, and it cannot, therefore, accept further fluxes in that direction. Since flux in the minor aperture outer leg is saturated, it must look to the next easiest path. This it finds around the major aperture shown schematically on Fig. 2 (*b*).

It is now easy to appreciate the condition of the "0" and the "1" within the core. The setting of the amount of flux around the minor aperture is dependant on the setting current, thus, analogue setting within the core is possible. If the current through the minor aperture is reversed, and, hence, the direction of the flux, the flux switch can be local. Consequently, this does not effect the rest of the flux within the core itself and the MAD element has a diode-like characteristic. Now, we have the condition in the core that we call the "0" and the "1".

Referring to Fig. 2 (*c*), we can see that, if a suitable signal is fed through a minor aperture with a "1" set in it and a detector winding is also threaded through this aperture, the flux will, in fact, change direction about that minor aperture in sympathy with the drive current. Hence, the output will be detected as there will be flux change within the turns of the detector winding. If a core, however, be in the "0" condition, then all the flux is saturated in one direction and the drive pulse will only tend to saturate the core; there will therefore be no change of flux and no output pulse indicated. This can be shown by feeding 500 kc's r.f. current of some 200 to 300 mH through a minor aperture, and the detection can be a small incandescent lamp of about 100 mW, giving us the continuous non-destructive read-out properties of the multiaperture cores. This simplification of the read-out gives a condition where, if the lamp fails in the "1" condition, you get a "fail safe" condition. By similar thinking, putting in a negative and positive-going square loop pulse, it is possible to have a pulse out-put from a core which can be detected and used to trigger other circuitry.

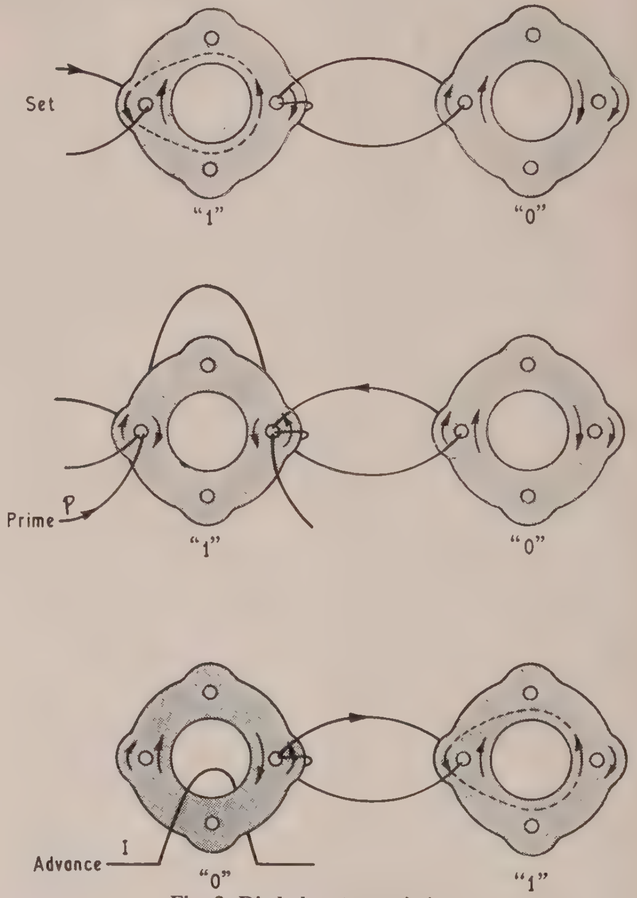


Fig. 3. Diode-less transmission.

With reference to Fig. 3, it is shown we now have several cores linked together, and, by inter-connecting the appropriate elements with coupling loops and working the system within its design conditions, it is possible to transmit the information stored on the first core through to the adjacent core. The cores are wired together with coupling loops, the left-hand core being set in a condition where it has a "1" in it. No flux is set into the second core from that of the first during setting as the flux switches through the axes, therefore, no current flows in the coupling loop. Now, if a prime current "P", either d.c. or pulsed, is passed through minor apertures of the cores, the ferrite material, being basically lazy, will tend to follow the direction influenced by the prime current; the time and current required to do this is not enough to influence the setting of the second core. If an advance pulse "1" is applied to the first core, the flux within this core will be changed into the "0" condition, and, in doing so, the flux about the right-hand minor aperture will change. Depending on the circuit conditions, a current pulse will be transmitted along the loop and hence set the second core into a "1" condition. The cycle is complete since the left-hand core is now in the "0" condition and the right-hand core has a "1" in it. This then, shows the method of dealing with transmission along the core.

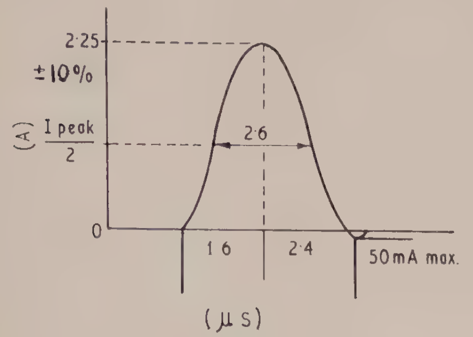


Fig. 4. Advance pulse.

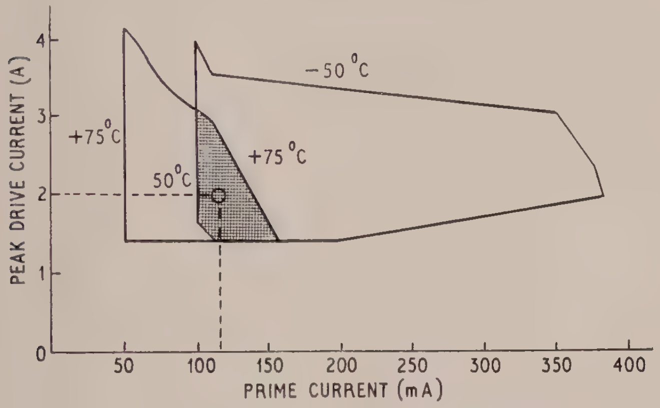


Fig. 5. Range map showing preferred operating point.

A typical advance pulse is shown in Fig. 4. The shape of this pulse is governed by the specific circuit parameters of the device controlling the shift of information. It is possible to vary conditions of drive and prime current and the coupling loop, but in order to have reliable working, it is essential that the design conditions be adhered to. The cores themselves are temperature conscious and this brings in a further variable.

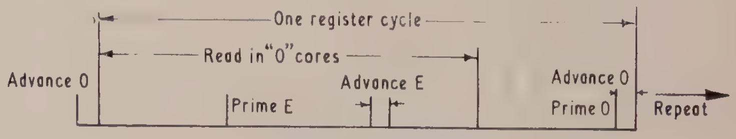


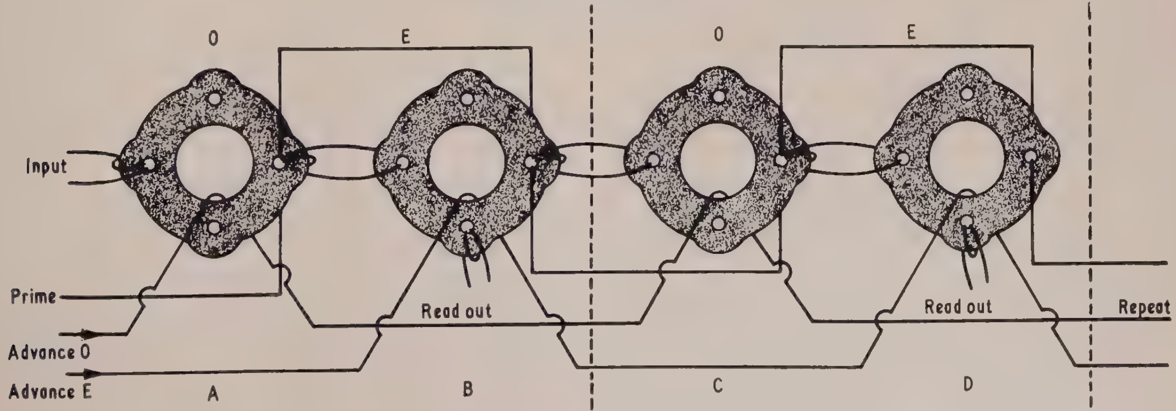
Fig. 7. Operating time cycle.

Fig. 5 shows the parameters under which a typical core will work. This is called the range map and it can be seen that the tolerances are indicated by the shading. Within this shaded area, the device will work correctly and, when choosing the environmental conditions, it is always essential to start so that it will work in the optimum condition.

If reference is made to Fig. 6, it will be seen that the wiring of part of a register is shown diagramatically. It will also be noticed that two cores are joined together with a winding marked Advance "O" and two cores marked with a winding Advance "E", the prime winding being common to all four cores. The reason for this is that where coincident "1's" are put into a register of this nature, it is essential that the information be passed into the register. Since the cores can only be in one condition at a time, when the transmission is taking place between core "A" and core "B", no in-put into the minor aperture would have any effect, thus, it is essential to have two cores per bit. Information may be taken from the cores at any time by using the unwired minor apertures.

In Fig. 7 can be seen a typical time-cycle of such an arrangement. The basic theory has been kept as simple

Fig. 6. Schematic shift-register circuit.



as possible in order that, on first investigation, the fundamentals are appreciated. A great many things influence the workings of such a device and many years of research go into producing a theoretically simple device into a reliable off-the-shelf working component. Once a device, such as shown, is manufactured with just wire and cores, there is very little that can go wrong with it; the components are unaffected by radiation and possibly the greatest weakness in mechanical construction is the fineness of the winding wires. These can be electrically protected in use quite easily, thus, we have a non-destructable shift register made out of components which are free of extraneous electrical components. By the use of complex windings, it is possible to achieve many logic functions using core and wires only, and to name some of these gives some idea of the flexibility of such a unit. Already mentioned is the shift register and a whole series of control devices can be arranged around this unit: command fanning, complementing "AND" and "OR" gates, sequential selection, decimal counter, word generation, digital comparator and analogue storage planes.

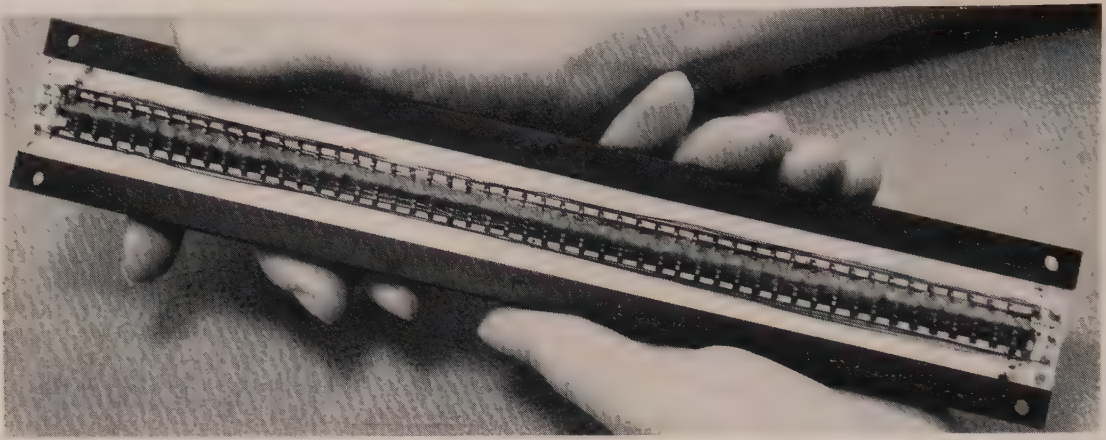


Fig. 8. 50-bit shift-register for AMP Mobilab.

Where logic is used then there is an opening for the MAD device, and the advantages of continuous read-out and the use of inert components make this system one with a big future.

International General Electric Company of New York

DEVELOPMENT OF NEW CARDIAC PACEMAKER

AN AMERICAN WOMAN suffering from a once-fatal heart disease now leads a normal life because of a cardiac pacemaker which has been surgically implanted in her body.

Developed by engineers of the International General Electric Company of New York in co-operation with a New York surgeon, this electronic device provides an electrical impulse that causes the heart to beat in proper rhythm. The electronic aid becomes necessary when the heart's normal impulse, supplied through the body's nervous system, is weakened or destroyed by Stokes-Adams disease.

Pacemakers have been successfully employed for such cases only in recent years. Further development was part of a programme to improve such devices and extend their usefulness to other areas of medical electronics.

This development began about two years ago when Jerome J. Suran, manager of Advanced Circuits at the Electronics Laboratory, consulted with Dr. Adrian Kantrowitz, head of cardiovascular surgery at Maimonides Hospital in Brooklyn, New York. Suran had heard of Dr. Kantrowitz's experiments in medical electronics and was eager to know how the Laboratory might assist.

Suran formed a team of engineers to work on medical electronics, and when a patient suffering from Stokes-Adams disease was admitted to Maimonides Hospital, work on an improved, implantable heart pacemaker began.

In the natural course of the disease, the patient's pulse rate had dropped to 20 beats per minute, barely high enough to sustain life. Normal procedure called for the immediate implant of steel electrodes into the heart tissues to supply impulses. An external pacemaker was employed until the implantable device could be designed and built.

Dr. Kantrowitz specified that the new pacemaker was to permit temporary increase in pulse rate for occasions when the patient was engaging in strenuous activities. External control of pulse rate had never before been provided for an implantable device.

As reliability was the paramount consideration, the circuitry was kept as simple as possible, and only extremely dependable solid-state devices were used as active components.

Before the surgical implant could take place, a working model had to be tested externally for a two-week period to make sure that the impulses of the unit were compatible with the requirements of the patient's heart. While the tests were running, the final model and an operating spare were constructed and encased in an inert plastic. When Dr. Kantrowitz performed the surgical implant, three engineers were in the operation room as members of the surgical team.

Adam Klisz, the mechanical expert, had developed techniques and special tools for welding the connecting wires and for sealing the plastic insulation. He was assigned to observe and advise the surgeon during these procedures. Heinz Raillard and John Schmidt were standing by to make any electrical measurements required during the operation.

The patient is now leading a normal life, and is able to do any of the things that could be expected of a woman of her age. Her pacemaker is completely self-contained with a set of batteries that will last from 3-5 years before requiring replacement.

The regular rate of the pacemaker is fixed at 65 beats per minute.

She has a second unit that she can wear if she wants to increase her pulse rate for any reason. This device has a calibrated potentiometer that can be set at any pulse rate from "70" to "125". It is about the size of a miniature transistor radio and has a flat circular antenna which is worn over the spot where the pacemaker is implanted.

Articles Provisionally Scheduled to Appear in Future Issues of this Journal

The Stability of Permanent Magnets.

Some Aspects of Component Reliability Data

Microphones (Part 3).

Transformers in the Electronics Industry (Parts 2 and 3)

The Silicon-controlled Rectifier.

Industrial Plastics for the Electronics Industry.

Fusing.

Superconductive Circuitry.

Use of Glass Fibre in Electronic Components.

Retainers and Fasteners.

Recording Heads.

Problems Involved in the Manufacture of Sub-miniature Radio and Electronic Components.

Thermofit Caps.

Application of Tesamoll to the Radio and Electronic Components Field.

Vacuum Forming of Plastics in Relation to Radio and Electronic Components.

Components for High-fidelity Equipment (Parts 1, 2 and 3).

Glow-discharge Tubes (Parts 1, 2 and 3).

What to Look for in the Design of Holding and Switching Components.

A Review of Non-linear Resistors.

Glass Applications in Transistors.

Termilode Waveguide Loads.

Survey of Wound Cores.

Survey of Modern Battery Practice.

Printed Circuit Soldering Line.

Design and Testing of Electronic Circuits.

Ceramic Components.

Battery Research and Development.

Cold-cathode Thyratron for High Current Control.

Fans for Electronic Cooling

Pre-packaging.

Applications of Permanent Magnets.

Surveys of Valves.

Constant-voltage Transformers.

High-power Spark Gaps.

Mercury Gas Thyratrons.

Manufacture of Miniature Diodes.

Chemical Etching of Silicon.

Avalanche Transistors.

Trigger Circuits for S.C.R's.

Examination of Spike and Flat Leakage in TR Cells.

The list does not include the regular features, i.e., New Components, Activities in the Industry, Manufacturers Publications and Personalities. Other additions will be reports on Conferences and Exhibitions, together with news features, articles and items of topical interest.

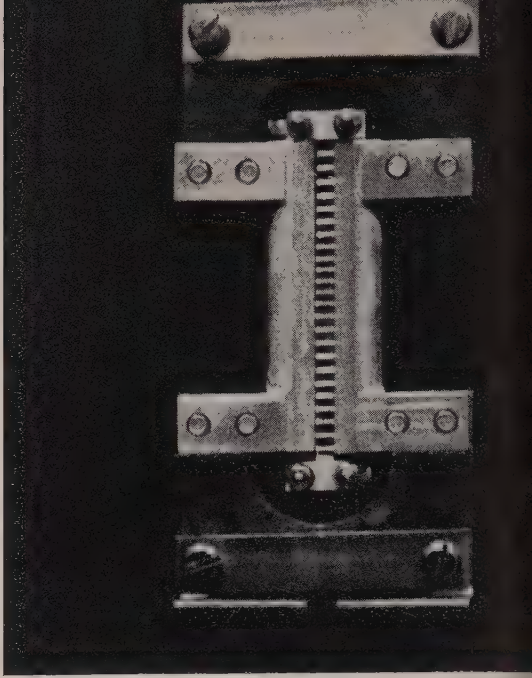


Fig. 1. Interior of a Lustraphone VR. 53 ribbon micro
showing ribbon suspended between the two pole-pieces.
(Photograph by E. J. Millen)

MICROPHONES

By G. R. Pontzen,
A.M.Brit.I.R.E.*

PART 2.
CONSTRUCTIONAL DESCRIPTION

A survey grouped into three separate parts for the purpose of (1) Classification, (2) Constructional Description and (3) Application in Practice. Particularly in consequence of the substantial and still growing popularity of Tape Recording, the necessity of attaining a basic knowledge of Microphones has acquired a new significance.

Introduction and Recapitulation

A SHORT reference to Part 1 of this article, published in the May issue of this *Journal*, is indicated to give an introduction to the more detailed analysis of various types of microphones from a practical angle. In particular it will be found helpful in the considerations to follow if we recall the essence of the definition given in Part 1 when it was stated that **a microphone acts as a two-fold converter of energy, transforming (1) acoustic to mechanical and (2) the latter simultaneously to electrical energy.**

It is interesting to note that the three main groups of stage (1) conversion: pressure, velocity and cardioid operation, can be achieved by a number of different methods as indicated in the small chart in the first article on *Classification of Microphones*. To facilitate cross-reference, it will be useful to adhere to the sub-division given there, which outlines the basic constructional principles of various types of microphones. Only brief reference is made to functional grouping and application to provide the requisite amount of continuity.

Design Considerations

Several vitally important problems face the designer of a microphone which is intended to satisfy the continuously growing demand for improvement in the quality of reproduction—the difficulties and pitfalls in both stages of energy conversion being of great diversity:

(*a*) The necessity to maintain a high conversion efficiency or, in other words, to keep losses in the system at the lowest possible level. As we set out with exceedingly small quanta of energy in the form of sound waves imparted to the sound "collecting" device of the microphone, and are committed to supplying a relatively substantial amount of electrical energy to our amplifying apparatus, the margin of permissible losses is small indeed. In spite of considerable advances being made all the time in the design and manufacture of valves and transistors, we still have to contend with a basic noise level in any given amplifier circuit. The required output from the microphone—and, where necessary, its associated transformer—must in consequence be comparatively high, in order to achieve a satisfactory signal-to-noise ratio.

(*b*) Attention was drawn in Part 1 to the acoustic effect known as diffraction which adversely affects frequency response to an increasing degree corresponding to an increase in the size of a microphone. The logical conclusion would be—well, let's design a small one. The diffraction effect is low, and the users will be delighted—nobody wants a large microphone these days!

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* Lustraphone Ltd.

But this is where the trouble starts. The two requirements are conflicting to such an extent that, irrespective of the system of energy conversion employed, the economic factor comes to the foreground. High conversion efficiency would be most readily achieved by: Large diaphragms for Stage 1 (Acoustic-Mechanical) and large magnet systems in the substantial groups of dynamic microphones for Stage 2 (Mechanical-Electrical) conversion. Obviously, a large diaphragm area pre-determines the overall size of the instrument—and the diffraction effect is correspondingly large: the reduced energy available for Stage 2 conversion when a diaphragm of smaller size is used necessitates, in consequence, an increase in efficiency of the associated system providing this facility.

Only a substantial increase in the precision of manufacture can achieve this result, at correspondingly higher expense.

(*c*) Whatever the ultimate destination of a microphone may be—and this is meant both functionally and geographically—its construction should provide the maximum amount of flexibility in application and use in climatic conditions in most parts of the world. The case where a special design is required for one application only is comparatively rare, and frequently an equipment designer considers the microphone problem only at the last moment, when his development work is almost complete. In this instance, the microphone manufacturer with an extensive range of models is in the fortunate position to assist—but this does not alter the fact that early consultation between him and the equipment designer is invaluable. Robustness is one of the foremost requirements in constructional considerations, as it has to be borne in mind that, whatever the equipment used, the microphone bears the brunt of shifting around, exposure to moisture and temperature changes, frequent handling and, alas, occasional mishandling.

Having dealt with the more general considerations which apply to microphones of all types, we can now proceed with the more detailed description of individual groups. We begin with "Generators" (Item 1):

1.1. Dynamic microphones

We should recall here the principle of the operation of dynamic microphones which is based on the fact that a voltage is generated by an electric conductor intersecting lines of magnetic force.

1.1.1. Moving-coil microphones

Only about one decade ago, the main emphasis was laid on maximum attainable sensitivity, i.e. high electrical output for a given amount of sound energy imparted to the diaphragm, in preference to smooth frequency response. The limitations were considerable, chiefly due to the relative inefficiency of magnetic materials used in the permanent magnets which provide the magnetic force. This necessitated physically large magnet systems, and correspondingly large diaphragms were employed. This, however, had unsatisfactory results from acoustic points of view as discussed in a previous paragraph. The magnets themselves were ring-shaped, in order to obtain a sufficiently large mass of magnet material. Today, in consequence of very substantial improvements in this field the ring-shaped magnet construction is relatively less popular and the modern design features the centre-pole magnet which offers substantial advantages. Magnetic screening is considerably improved and leakage flux reduced, the size markedly smaller and, due to greater efficiency, there is no comparative loss in the overall magnetic performance which is determined by the flux density in the airgap. An important constructional point in a modern moving-coil microphone is the finite location by mechanical means of the inner pole piece with respect to the outer magnet ring to make any relative movement of the two parts impossible and maintain the airgap constant (see Fig.2). The electrical output of the instrument furthermore depends upon the length of the conductor intersecting the magnetic lines of flux and this, obviously, is controlled by the number of turns of wire in the moving coil which is attached to the diaphragm. Again several conflicting requirements face the designer:

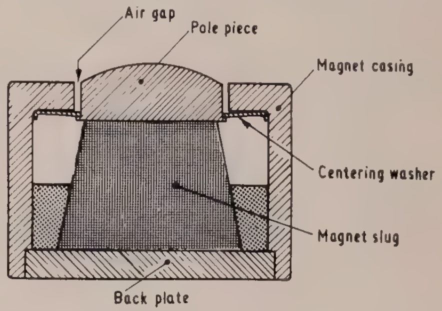


Fig. 2. Centre-pole magnetic assembly of moving-coil microphone.

(*a*) Only a limited space is available in the airgap and a reasonable distance has to be allowed inside and outside the coil to ensure free axial movement without touching either the pole piece or the outer ring.

(*b*) In theory, it would follow from the earlier considerations that all we have to do to achieve high output is to wind our coil with very fine wire and thus obtain a large number of turns to provide a long conductor. This is possible but only at the expense of durability and higher cost due to more difficult production methods. Here we find one of the fundamental differences between British and American moving-coil microphones on the one hand, and continental types on the other: the standard impedance of the former is around 20-30 Ω and that of the latter 200 Ω. Our own chief objection to 200 Ω coils is based on the greater fragility and consequent risk of mechanical fracture of the very fine wire used, as well as the increased possibility of fracture due to corrosion, quite apart from limitations in application with British equipment specifying low impedance inputs (see **Impedance Matching Chart** published in Part 1). This aspect, however, takes us outside the scope of this section and will be treated in Part 3.

(*c*) Taking problems (*a*) and (*b*) into account, a compromise has to be reached, since the greatest magnetic efficiency i.e. the smallest possible airgap which requires the maximum amount of precision machining and assembly, presents considerable difficulty in providing the coil with sufficient space for free movement.

Having discussed the mechanical-electrical aspect of the moving-coil device, we can now proceed to the acoustic part which is composed not only of the diaphragm carrying the coil but, in most modern microphones, of intricate combinations of cavities, tubes and textile materials. In acoustic "circuitry", these represent capacitance, inductance and resistance respectively in that order in equivalent electrical circuits. These additional facilities are of the utmost importance in order to achieve the desired frequency response characteristic of a given microphone type, as we can see from the following considerations:

A system, as described before, has a fundamental resonance which is essentially dependent on the mass of the moving element (i.e. diaphragm and coil combined) and the stiffness of its suspension. This resonance would produce an equivalent electrical peak in the output of the microphone *and*, as it happens to be well inside the audio frequency spectrum, the frequency response of such a microphone would be totally unacceptable. One way of reducing this peak would be to damp it by means of an acoustic resistance but this would be entirely wasteful—it has already been stated that it is not easy to attain the minimum output level required by an amplifying system in order to avoid trouble from its inherent noise level. Consequently, the correct way to deal with this contingency is to partially damp out the resonance and introduce acoustic correction in the form mentioned, which produces additional resonances and, if correctly designed, results in a relatively flat frequency-response curve at a substantially higher level than we would have achieved merely by resistive damping of the main resonance.

One most important aspect of the system is correct diaphragm design and material. It is vital that the mass should be low in order to permit it to follow transient impulses faithfully—that it should be capable of moving freely yet only in the direction perpendicular to its plant; that its restoring force should be equal in both directions from the rest position; and that the material should withstand climatic and violent pressure changes without suffering damage. Both aluminium foil and certain plastic materials are suitable to fulfil these pre-requisites but it is apparent that the diaphragm is possibly the trickiest detail of a microphone. Yet another intricate component part is the moving coil proper, and similar requirements to those relating to the diaphragm apply: low mass, high resistance to adverse climatic conditions and to corrosion. A very important point is the necessity for a good space factor which means that the very limited space available in the airgap should accommodate as many turns of wire as possible. In good quality microphones the coil is often formerless and self supporting. The design of the outer case also plays an important part in this connection.

As we have already seen from the small "family tree" showing the essential classification, the moving-coil type of microphone is the most versatile of all, as the system lends itself to practically any combination of pressure and pressure gradient operation, depending on different methods of diaphragm mounting; consequently, a large variety of different models is available, ranging from expensive studio-microphones (omni-directional or cardioid) through medium-priced communications, recording and public address types (again both versions) to cheap general purpose models especially for domestic use with tape recorders, the latter being chiefly of the pressure (omni-directional) type as this represents the least complicated design and can therefore be produced at the lowest cost.

Two highly specialized versions of the moving-coil group are the noise-cancelling microphone and a quite recently developed new type of contact microphone; the latter should not really bear the title "microphone" as it is meant to be purely a mechanical-electrical transducer. In fact, the difficulty with a transducer of this nature is how to prevent it from picking up incidental sound whilst being outstandingly sensitive to the most minute vibration of its sensitive actuator which is coupled to the moving-coil system. The noise-cancelling microphone deviates from all other current types in so far as the diaphragm assembly is so arranged that both faces are entirely open to the surrounding air and, consequently, the diaphragm is only actuated by a sound source in close proximity to the diaphragm whilst all other sounds tend to move the diaphragm in both directions simultaneously, and thereby cancel out. More detailed attention will be given to these two special instruments in Part 3.

1.1.2. Ribbon microphones

We are already aware of the fact that this group is logically classified as a dynamic microphone, the ribbon itself representing the electric conductor in the magnetic field and simultaneously the acoustic pick-up device or diaphragm.

We are going to concentrate on the most popular type which is the straightforward velocity model with a figure-of-8 polar characteristic—a description of pressure and cardioid ribbon microphones must be precluded due to the limited space available, the basic principles having been discussed in Part 1.

In spite of the basic similarity, in principle, with the moving-coil microphone, the design requirements of a ribbon microphone are vastly different.

To begin with the magnet system, this is called upon

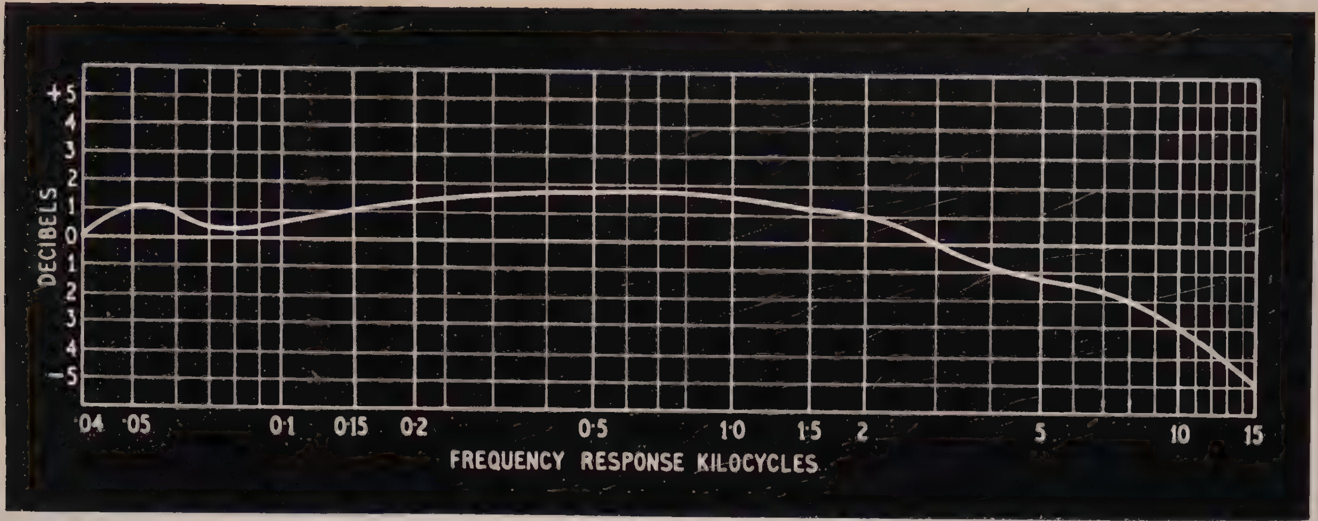
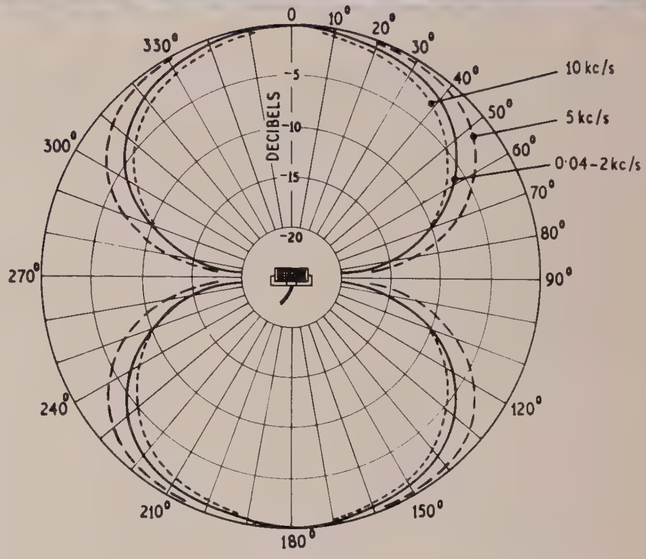


Fig. 3. Typical response characteristic of a ribbon velocity microphone (Lustraphone Model VR 53). Top shows the frequency response and right is the polar diagram.



POLAR DIAGRAM

to provide a magnetic field straight across two parallel pole pieces, preferably in such a manner as to provide a perfectly symmetrical mechanical arrangement both in the back-to-front and side-to-side directions. A convenient method of construction is to place two horseshoe magnets at the top and bottom of a pair of straight pole pieces (see Fig. 1), with the magnetization arranged in such a way that the two form opposite poles across the parallel gap. The ribbon which consists of exceedingly thin aluminium or Duraluminium foil is suspended freely along this gap between two pairs of clamps which provide both mechanical support and electrical connections. The clamps are arranged so as to permit the ribbon to move only at right angles to the direction of the magnetic field and, in some high quality models, one clamp is adjustable to allow variation of the longitudinal tension which determines the resonant frequency of the ribbon. The ribbon itself is corrugated and the method and shape of corrugations varies considerably between different manufacturers.

Similarly, with respect to the problems in the design of moving-coil microphones, compromises are necessary to overcome conflicting requirements. The magnetic circuit would be most efficient with the narrowest possible gap between the pole pieces; on the other hand, for a given length of the ribbon, the width determines the area available for sound pick-up—it is not difficult to see that a very narrow ribbon will not be of much use even in the strongest of fields. A further difficulty is the limitation in length which should not exceed 2 in. Excessive length can cause inconsistency in the polar response and there is danger of spurious resonances in the ribbon which adversely affect the performance; also, the danger of flutter due to draughts is increased.

Effective blast screening is an important aspect and a correctly designed ribbon microphone with adequate protection in this respect can last a lifetime, provided that it is not misused.

The outer casing, whilst designed to withstand every mechanical contingency, should be acoustically "nonexistent" and this is one reason why some of the highest quality microphones have the appearance of very simple shrouds of wire mesh or perforated metal.

The exceedingly low impedance of the ribbon element (a fraction of 1 Ω) necessitates the use of a transformer, built into the microphone proper, and subject to the obvious requirement regarding adequate frequency response of this transformer, it can be stated that a velocity ribbon instrument as described is one of the very best microphones available for indoor use. A glance at the typical response curve will confirm this view.

1.1.3. Electro-magnetic microphones

As indicated before, two essentially different designs are in large-scale use today, one of which is gradually being replaced by the other, due to substantial advantages in performance.

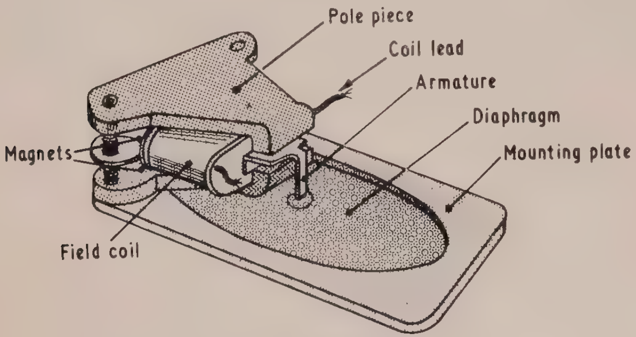


Fig. 4. Electro-magnetic microphone insert.

(*a*) The first type is that which could be regarded as a telephone receiver in reverse (it may be appropriate to mention in this connection that recent models of such receivers also incorporate the second system, we are going to describe) and is of great simplicity. The principle is based on a permanent magnet system with a stationary field coil through which part of the soft-iron magnetic circuit is passed. In close proximity to the end of the magnetic pole so created is an iron alloy diaphragm which completes the magnetic circuit through its peripheral suspension. One of the chief disadvantages of this arrangement is the necessity for great stiffness of the diaphragm to prevent its "clicking" permanently against the pole piece instead of maintaining the narrow airgap which forms the basic element of the function as a microphone. When the diaphragm is actuated by changes in sound pressure, its distance from the pole piece is increased and decreased in sympathy with the sound wave, and the permanent magnetic flux through the system varied accordingly. The flux variations, in turn, cause an equivalent voltage to be generated in the stationary coil which is all nicely in line with our definition of a dynamic microphone. The fact, however, that a *permanent* flux is altered above and below its static value, and therefore aids diaphragm motion in one direction and opposes it in the other, causes non-linear distortion in the electrical output. Furthermore, the stiffness of the diaphragm severely restricts low-frequency response and the whole system, whilst capable of giving substantial output, is not any longer considered suitable to provide adequate speech reproduction.

(*b*) The second method of operation using a static coil and changes of flux in an associated magnet system is the balanced armature arrangement which can assume a multitude of designs different in detail but all based on one essential principle—that the armature in its rest position does not carry any magnetic flux and that, consequently, the excursions of the diaphragm from its rest position in both directions cause equal and opposite flux through the armature; from this, the conclusion can be drawn that the corresponding electrical output is essentially free from non-linear distortion due to causes encountered in the system described under (*a*). One particular design which lends itself not only to operation as a pressure type but also to the construction of an efficient noise cancelling microphone, can be described in the following manner.

A thin armature of high permeability alloy is clamped near one end between two equal bar magnets and passes through a stationary field coil, with its other end situated in an airgap between two pole pieces which, in turn, are fixed on the outside faces of the two magnets, and hold the coil in position. An extension of the armature is bent up at right angles and fixed to the diaphragm; this is mounted parallel to the armature on a mounting plate, the end of which carries the magnet and coil assembly. It can readily be understood from the illustration that the flux through the armature must be zero if the magnets are equal, magnetized in the same direction, and the two pole pieces equidistant from the armature.

When efficient magnet circuitry is employed, high electrical output can be achieved. The coils can be wound to obtain impedances up to 2,000 Ω.

1.2. Crystal microphones

A fairly detailed description of a diaphragm-actuated piezo-electric microphone was given in Part 1 and, without going into details involving theoretical aspects beyond the scope of this article, very little can be added to it.

It is worth mentioning that some disadvantages, especially climatic limitations, quoted for the most commonly employed crystal (Rochelle Salt) are, to a great extent, overcome by new synthetic materials. One of the main features of Rochelle Salt, however, is its high electrical output and this has not been equalled so far in such materials. This drawback naturally limits the application of these new crystals for the time being, unless further fundamental development work achieves a substantial overall improvement.

A second method of constructing a piezo-electric microphone is the so-called direct actuation system which is achieved by two crystal elements being mounted with an enclosed air-space between them. The necessary mechanical distortion is originated by variations in sound pressure on the outside of such a combination which is called a sound cell. A number of these can be connected together and this is undoubtedly an essential feature due to the fact that the sound cell is far less sensitive than the diaphragm-operated unit. The reason for this is the considerably smaller surface area of the former; the frequency response of a sound cell microphone is, however, far superior to that of any diaphragm-actuated one—there is no diaphragm resonance to contend with, nor are there any considerable diffraction effects such as those caused by the considerable size of a diaphragm-actuated unit.

Sound cell microphones have lost a lot of their popularity in recent years, as they are quite expensive to produce and are still subject to the limitations already quoted.

We still have to deal briefly with the "Modulators" group (Item 2) and begin with:

2.1. Carbon microphones

The best-known specimen carbon microphone is the type still in use with the G.P.O. and again, there is little to add to the description already given in Part 1. One point of some importance, although of rather limited application, is the distinction between single-button and double-button carbon microphones. The G.P.O. microphone used in the telephone system is of the former type which is also still widely used in American aircraft radio communication equipment. The double-button microphone requires special circuitry, in so far as it consists of an arrangement comprising three electrodes with the carbon granules interposed between them. The two outer electrodes are fixed and the diaphragm is connected to the centre electrode which, in the process of vibration, simultaneously increases the resistance to one fixed electrode, and decreases the resistance to the other, thereby providing an electrically balanced circuit. Consequently some of the non-linear distortion which is prevalent in a single-button carbon unit is cancelled out and substantially improved reproduction results.

In general, carbon microphones are used as pressure operated devices only. As usual, however, one exception proves the rule as there is, or was, a carbon noise-cancelling microphone in existence in the United States of America.

2.2. Condenser microphones

As discussed in Part 1, two distinctly different types of "Capacitor" microphones are on the market—although the principle of operation is identical.

The domestic model which, to the writer's knowledge, is only produced in Germany, provides sufficient electrical output to be used without a pre-amplifier and is entirely "married" to equipment providing the required d.c. polarizing voltages of approximately 100 V. In this instance, frequency response considerations are sacrificed to the paramount requirement of obtaining adequate output and this can only be achieved by large physical size. This, as we have mentioned, causes diffraction effects which adversely affect the performance. The construction is ingeniously simple, with the diaphragm consisting of a thin plastic sheet coated on one side with a metallic film, suitably stretched and peripherally suspended close to the static plate. This type is produced as a pressure operated microphone only.

Professional models include purely pressure types or, as stated in Part 1, combinations of progressively variable operations. Precision work of the highest accuracy obtainable in mechanical engineering is required, in order to allow the diaphragm to be situated in close proximity to the static plate, without the possibility of touching it, even when subjected to exceptionally high instantaneous sound pressures. The physical size is usually quite small; on the average, the diameter of such an instrument today rarely exceeds the size of a penny and this achievement brings the reward of insignificant diffraction effect. Coupled with the inherently excellent frequency response characteristic of a correctly designed microphone unit, in which the diaphragm resonance is placed above the audible range, there is ample justification for the popularity enjoyed by this microphone for Studio and Broadcasting work. The associated pre-amplifier and matching unit must of necessity be mounted in the same case as the microphone proper, in order to prevent losses in connection leads between the two. Looking at the impedance matching chart it can be concluded that the output impedance from the microphone pre-amplifier is designed for long lines, which is an additional advantage—but we must always remember that the high price limits the use of such a microphone to Broadcasting and Recording Studios and to the fortunate few!

It is hoped that the necessarily somewhat condensed description of the microphones chosen has provided the reader with sufficient information to appreciate some of the problems involved in the design, and to follow the forthcoming discussion on the application of microphones.

It is hoped to publish the final part of this article in the November issue.

★ ★ ★

Problems in the Manufacture of Mass Produced Precision Pressings. Part 2

By John Mortimer
C. Brandauer & Co. Ltd.

This is the second of two articles which show what a leading British manufacturer has done to overcome problems in the manufacture of mass-produced precision pressings for the electronics industry.

TOOLING for the production of miniature and sub-miniature pressings demands the ultimate in design, materials, machines and tools. If we take in the first place design of press tools and fixtures we must put ourselves into the predicament the designer finds himself when a new job appears. He must, for instance, consider and cater for the following factors:

(a) Length of run; (b) Economical price of components; (c) Accuracy of design and manufacture; (d) Minimum tool maintenance costs; (e) Practicability; (f) Type of material to be processed; (g) Type of tool steel to be used; (h) Simplicity of tool design to keep toolroom hours low.

Design

On simple or less complex components these problems can easily be solved. Standard text books give many of the answers, but miniature and sub-miniature presswork poses many problems—a great number of these have been solved already by means of research and the recording of results, but each week many more answers are found and faithfully recorded. It is necessary for design staff to keep a very detailed record of the many ways in which problems have been overcome, and these are tabulated and constantly referred to during the initial design stage to ensure that past experience is applied to today's problems. Design staff, in the initial stages, must have very full consultations with the toolroom, production and purchasing management to ensure that each facet of their problem is fully covered in order to ensure reliable production and deliveries. It is essential for them to have sufficient experience in their field of work to be able to appreciate the limitations of men, machines and materials.

Tool Construction

After design, the next real problem is the construction of the tool. Many years ago it was common practice in most tool rooms for a toolmaker not only to design his tool but make, finish and assemble the complete press tool.

This method, although dying out, is still far too prevalent, and any Company which intends to manufacture first-class tooling will meet the many drawbacks of this method of manufacture. As this method still exists, however, we will explain in some detail its disadvantages, and compare it with the methods used, for example, by Brandauer's who have developed a sectionalized tool room which is under very strict control and supervision and is capable of producing a very high standard of tooling for miniature presswork.

Design, as mentioned before, must carry thought, experience and accuracy. This can only be carried out by an experienced tool designer, and must be treated as an individual problem. Drawings are then issued to the machine shop; these drawings having been checked by the toolroom manager and production executive, represent a definite instruction. They also specify the steel, component parts and ancillary equipment necessary for the construction of the tool.

The machine shop receives these instructions and commences to cut off, shape, turn, mill, bore and drill the component tool parts. In this department the machine tools have been purchased with their ultimate accuracy, rate of stock removal and ease of working in mind. They are carefully maintained, replaced the moment such action becomes necessary and each machine tool is manned by an expert—the whole unit being controlled by an expert machinist who is responsible for accuracy and output rate to the toolroom manager. All machined parts are checked with the relative drawings fed into a work pan and then passed to a toolmaker who attends to such details as drilling, reaming and honing, etc. Certain parts are then hardened in an electric muffle and tempered to a predetermined hardness. This operation together with steel specifications can have a great bearing on ultimate tool life.

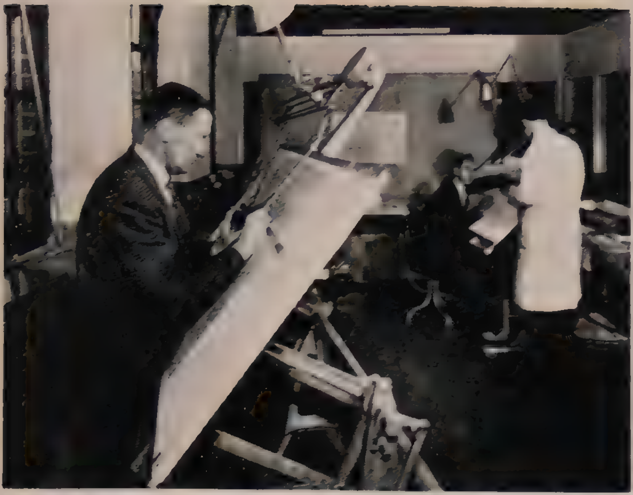


Fig. 1. Part of the drawing office, where all tools, jigs and fixtures are designed and drawn out. This office also retains the masters for reference purposes.

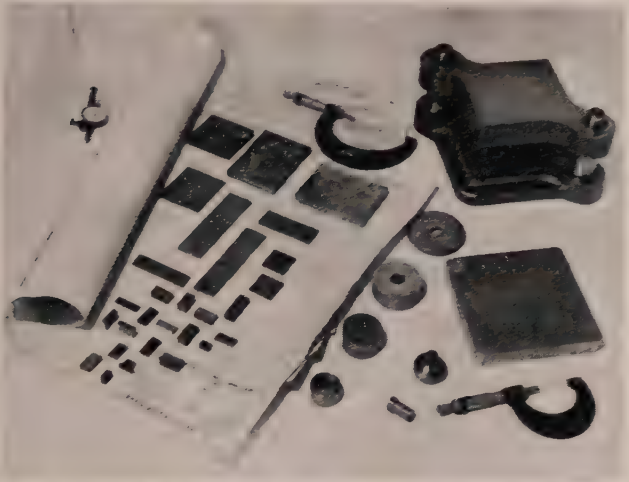


Fig. 2. A number of machined parts, a die set, and drawings ready to be issued to a bench hand.

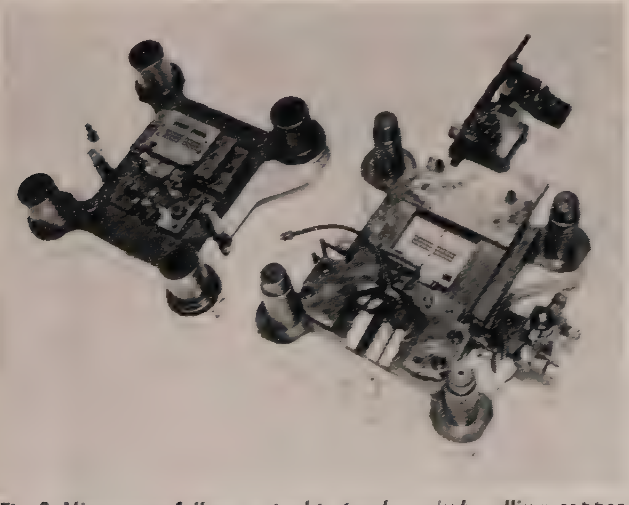


Fig. 3. Nine-stage follow-on tool to produce six beryllium copper components per blow from 0·006 in. material. The four-pillar die set fitted with ball bearing bushes to ensure accurate line-up over long runs should be noted. This tool was designed to produce 30,000,000 parts.

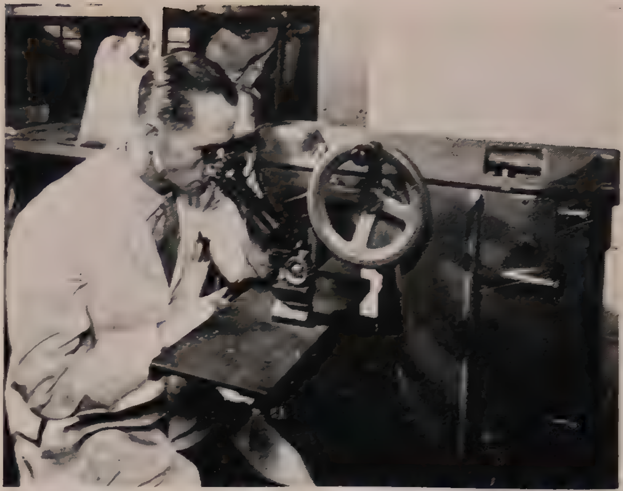


Fig. 4. Vickers Diamond Hardness Testing Machine which is used to test the hardness of all punch and die sections after heat treatment. The machine will also test the hardness of incoming materials and components after heat treatment.

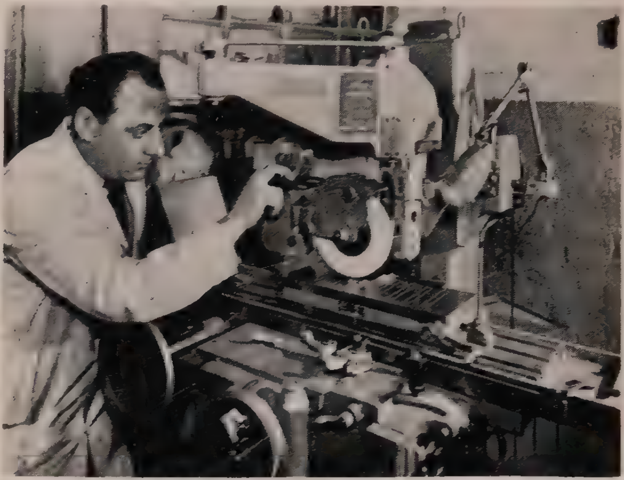


Fig. 5. Jones and Shipman 540 Surface Grinder fitted with a Dia-Form wheel dressing attachment for the accurate profile grinding of punches and dies. This machine is also fitted with a power rise and fall to the wheel head.

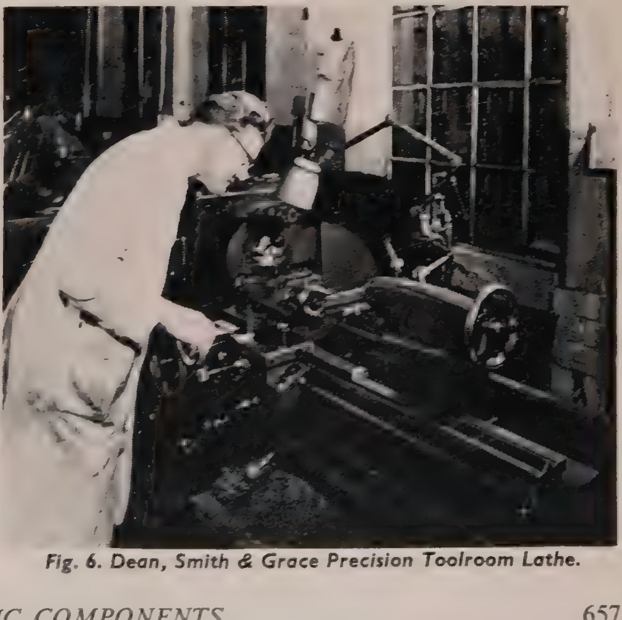


Fig. 6. Dean, Smith & Grace Precision Toolroom Lathe.

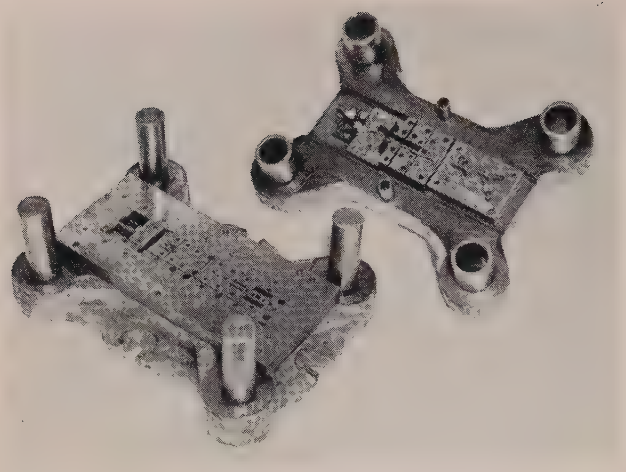


Fig. 7. A ten-stage follow-on tool designed to produce two contacts per blow from 0·008 in. hard phosphor bronze coil. All punch and die sections are ground and the average production between regrinds is 600,000 parts.

Each part is carefully checked for hardness on a Vickers Hardness Testing Machine and any part which fails inspection is scrapped and replaced.

Due to the fact that the achievement of high accuracy is expensive and also because steel can distort slightly in heat treatment, the ultimate accuracy of a press tool is imparted on hardened steel components. There may be as many as 150 designed into a complicated press tool, and it is not unusual to have fifteen progressions in a follow-on tool. One can easily see that an inaccuracy of, say, 0·001 in. in the initial stage could lead to an intolerable 0·015 in. on the eventual product, therefore, if one has to work to limits of ±0·0015 in., which is necessary in many cases, one has to control this particular operation to ±0·0001 in.

The grinding section, as with the machining section, is again manned by experts, who maintain their machines, make special attachments for them and concentrate their considerable skill on this one facet of toolmaking. It is to be hoped that, at this stage, the advantages of a sectionalized tool room are beginning to become apparent; basically, experts are in charge of each individual operation. The grinding operations are carried out on Jones and Shipman 540 Surface Grinders fitted with various attachments for profile and radius grinding; special jigs have to be made in many cases, and wheel specifications must be carefully chosen. Machine maintenance and cleanliness is as essential as good lighting and quietness. This section is split further in that the most up-to-date machines and the most skilled operators are engaged entirely on die and punch production; the slightly older machines and less skilled are put on maintenance and squaring-up of tool parts. This ensures maximum utilization of plant investment and also progressive training of personnel.

The grinding machine operators have to have a very real knowledge of press tool manufacture, for, as they produce the component parts they have to be checked for size against the drawings and returned to the toolmaker for actual fitting into the remainder of the press tool which, by now, is ready to accept them. The press toolmaker or fitter, fits the component parts together, checking at each stage. Here again absolute cleanliness, good light and individual benches to eliminate unnecessary distraction are essential. The tool having been assembled is now ready for a try out and a special press is installed in the toolroom for this purpose. At this stage the success of design and workmanship is severely tested, and it would certainly be untrue to say that any tool is perfect for production at the first attempt. In most cases, modifications to component parts have to be made, and these alterations or modifications are reported to the toolroom manager and designer and the drawing altered where necessary—any imperfections in machined parts being taken up with the machinist concerned.

A pre-production run is carried out after these modifications and the components are then submitted to a fully equipped inspection department prior to being despatched to the customer for his final approval. After the pre-production run the tool is again stripped for final checking and if found to be satisfactory passed to the production department.

This method of tool production ensures that only one man, an expert, uses one machine tool. If his work or his machine is inaccurate the errors can be pinpointed and either the man replaced or taught to overcome his difficulties, or his machine replaced or reconditioned. Each machine has a forward work load, so machine tool down time is at a minimum. Inspection of component tool parts is made easier, for if one man is responsible for all parts of a press tool he might make an error on one part, and to save scrapping it, makes a complementary part out of drawing to suit his initial error. This may not, in a single instance, be disastrous but if repeated many times, can make tool tryout times ridiculously long and maintenance extremely costly.

The writer has had experience of long and costly tryout periods and maintenance having to be done by the original toolmaker. The standard excuse of "well he understands that job" is really that he remembers to some extent all his deviations from drawing.

The other essentials, both from the point of view of maintenance and new tooling, are that the toolmakers are made aware of tooling and repair times. These must be accurately assessed, recorded, and visibly shown. Good, fast and accurate toolmakers are very rare. At Brandauer's a certain number of toolmakers are, by rotation, kept on new tools whilst others are detailed to maintenance. This ensures maximum concentration on the job in hand and also ensures that new tool completion times are practical and that an accurate measurement of maintenance is possible.

Each toolmaker clocks on and off each job, his hours are logged visibly on a production control wall chart and excessive times or lack of progress are spotted before it is too late.

A non-contributory pension scheme, good working conditions and a training scheme for young apprentices should ensure a continuity of enthusiasm and skill.

Conclusion

This then has been a necessarily brief outline of the industry as it stands today and a picture has, we hope, been given of the kind of complexities which personnel engaged in the mass-produced precision pressings field have to face. There is no doubt that these complexities will become even greater as higher and higher standards are required and extremes of miniaturization specified. Provided, however, that manufacturers prepare adequately for the problems that must come then the precision pressings industry in Great Britain will easily be able to compete with the best that the world has to offer.

PHOTOMULTIPLIER TUBES

As an Aid to Steel Manufacture

MODERN STEEL FURNACES can produce a "charge" of steel in ten minutes, but a chemist takes anything from an hour to a day to analyse a sample of the charge by wet chemical analysis. If the analysis then shows the composition to be incorrect, the charge has to be scrapped and the whole tedious time-wasting cycle begun again.

Hilger & Watts Ltd. has recently introduced the Polyvac-12 direct-reading vacuum spectrograph, for the rapid automatic analysis of carbon, phosphorus, sulphur, manganese, silicon and other elements in steel. It can determine eleven elements in less than three minutes—considerably faster than a photographic spectrograph. The sample can be analysed and verified or corrected, before the charge is poured. This is obviously of great help to the steel maker.

Bank of furnaces, capable of temperatures of 450-750°C, containing specimens with dial gauge extensometers attached.

Polyvac has four parts—a source unit, a polychromator, a console and a vacuum pump. The polychromator, in its simplest version, accommodates up to 12 photomultiplier tubes, supplied by E.M.I. Electronics Ltd. For more complex analytical requirements, a modified spectrometer fitted with up to 20 photomultiplier tubes can be used. E.M.I. photomultipliers are specified for this equipment because they are particularly stable and have a very low dark current.

Polyvac was designed as a vacuum spectrograph so that the far ultra-violet—where the best spectral lines for the important elements in steel making are found—should not be absorbed by the oxygen in the air.

It is a fully automatic instrument. The sample is mounted on a discharge stand and the start button pressed. Less than a minute later, the read-out system begins to present a series of results on a meter, recorder or typewriter. The analysis of plain-carbon or low-alloy steels is presented in 75 seconds. A rate of working of 130 samples—each sparked in duplicate—per eight hour shift can easily be achieved.

What happens is that the sample is sparked in a small chamber, where it acts as an electrode. Its light enters the spectrometer and is dispersed into a spectrum by fluorite prisms which are transparent to the far ultra-violet. The spectral lines of interest are isolated by narrow slits and their light sent to the E.M.I. photomultipliers by small mirrors.

The outputs of the photomultipliers are stored in capacitors, and the potentials of the capacitors are measured in turn at the end of the exposure.

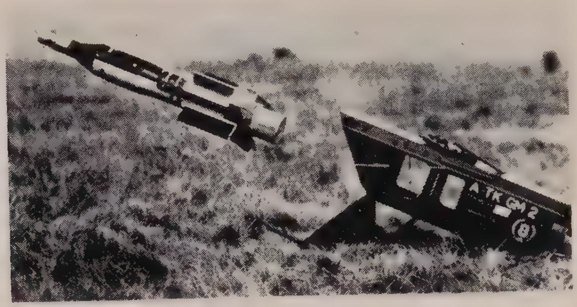
★ ★ ★

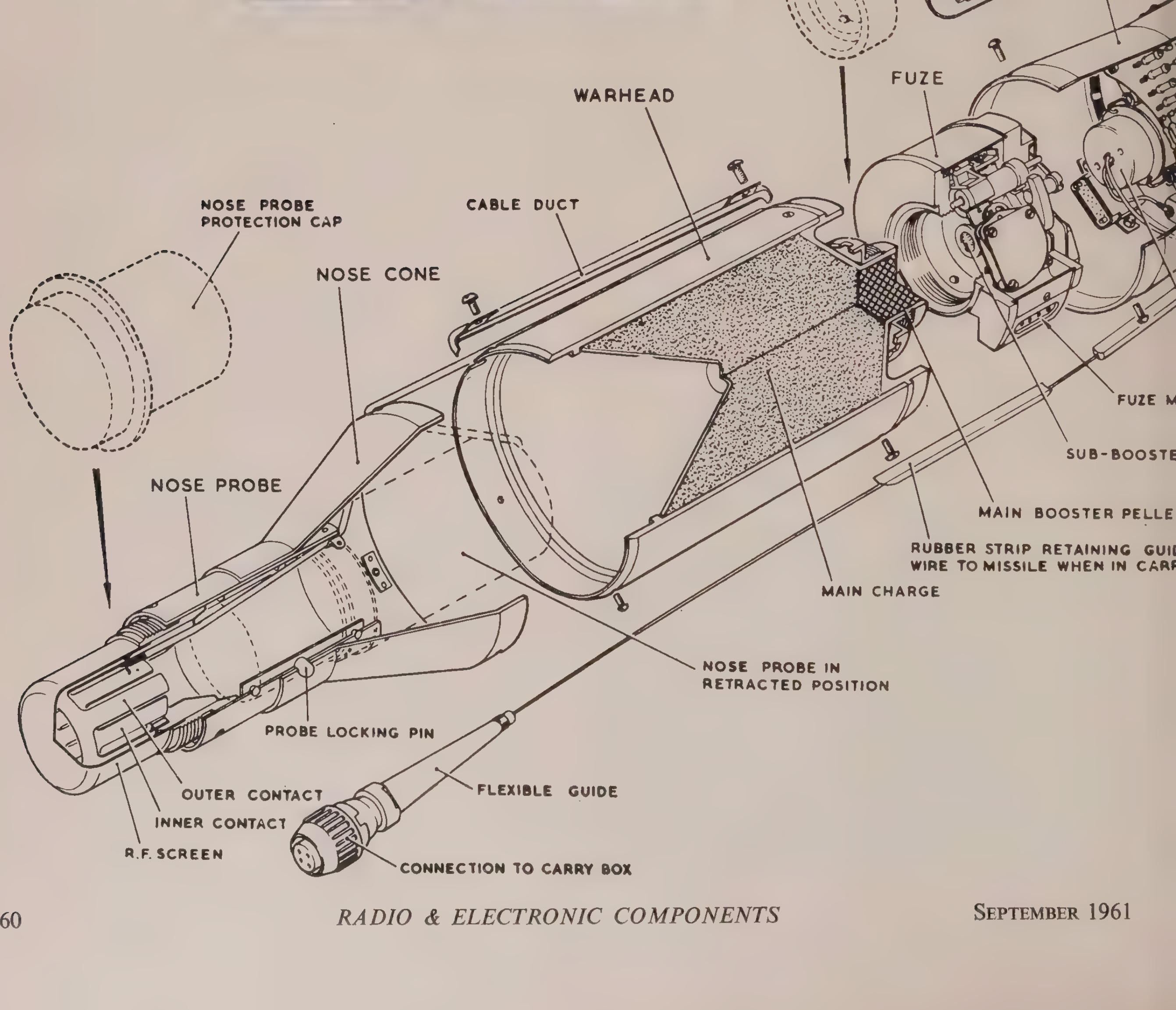
Demonstration of the

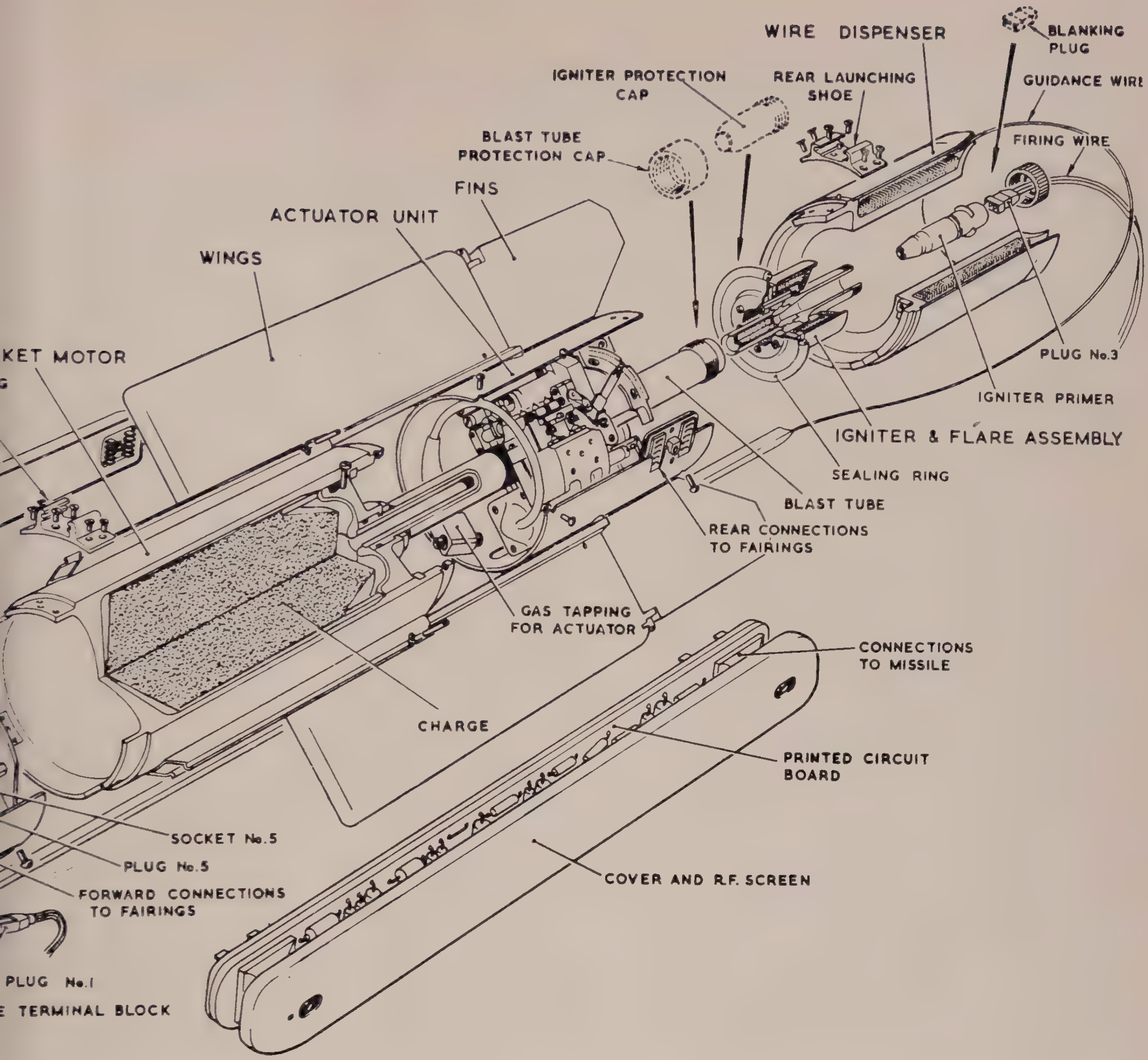
VICKERS VIGILANT ANTI-TANK GUIDED MISSILE

ON Friday, 7th July, a demonstration was given of the new Vickers Vigilant anti-tank guided missile. The demonstration was given by soldiers of the British Army School of Infantry, on Salisbury Plain near Warminster, Wiltshire.

The component parts of the weapon are shown in the illustration and its capabilities were more than adequately illustrated by the fact that twelve direct hits were scored on moving targets out of the thirteen shots fired.







Vigilant has been developed over the past four-and-a-half years as a private venture project by Vickers-Armstrongs (Aircraft) Ltd. The additional resources now available in the British Aircraft Corporation give adequate production facilities for world-wide orders. Development is now complete and a production programme is under way.

It has been designed to give a tank killing capability to individual soldiers. For airborne and commando operations, an attacking force equipped with Vigilants has an effective anti-tank weapon ready for firing within seconds of landing. The complete weapon system weight is under 50 lb.

The need for an infantry anti-tank missile is now being appreciated by many countries. Although Vigilant, with its more sophisticated control system, costs more than other missiles, the chance of scoring a hit is much greater and over longer range and wider angular coverage. The missile has its own auto-pilot which automatically corrects errors of course and all the operator has to do is to "cover" the target with a tracking flare in the rear of the missile. In practice, this means the most vulnerable part of a tank may be selected to ensure a kill rather than risk a glancing blow on the tracks or outer armour. The pistol-grip control unit is extremely easy to use and can be used by the operator to guide the weapon onto its target after little more than five hours training, and he can be up to 75 yards away from the missile at the moment of firing and still engage the target successfully.

Encapsulation Systems for Electronic Components

This article describes some of the modern developments in the encapsulation of components, and various processes are described. Under the agreement with Emerson & Cuming Inc., *Microcell's Electronics Division* at Blackwater, Camberley, Surrey, is responsible for the marketing and distribution in the United Kingdom of the American company's range of plastics designed specifically for the electronics industry.

M. C. Volk, A.B.

Emerson & Cuming Inc.
Canton, Massachusetts, U.S.A.

ELECTRONIC component packages are becoming steadily smaller and smaller. The term miniaturization, used to describe the new trend in circuit design some ten years ago, is being displaced by the designations "subminiature" and "ultramicro". Space and weight saving in military applications and portable or airborne communications equipment dictated the development of these small units and their reliability and serviceableness in use have led to their adoption over the whole field of electronics.

The miniature package is designed electrically to do the given job every bit as well as the 10- or 100-times larger unit it is to replace. This means, for the engineer designing the insulation, developing improved insulating materials and new approaches to insulation system design.

Specialized function, extreme use environments, long service life requirements, and extreme precision characterize the applications which employ insulated components. No longer does a dielectric which merely has high dielectric strength and high insulation resistance fill the bill. Custom tailoring insulating materials and systems to specific requirements of the job at hand has become an essential part of present-day electronics technology and encapsulation by a variety of processes is now an established means of achieving rugged, void-free, moisture-impervious insulation and protection. The plastics industry is meeting the challenges of component engineering with speciality dielectrics and improved techniques of application, as the following examples from the small components field will show.

Capacitors

Rugged, compact, completely solid structures are achieved by encapsulation. Freedom from leakage and drying out, which are common problems with liquid impregnants, gives improved reliability and extends service life. The use of low-viscosity, solventless encapsulants assures thorough penetration and void-free products.

The units must be thoroughly dried before processing and handled with extreme care to prevent subsequent moisture pick-up. Wound elements and multilayered stacks are first converted into solid structures by impregnation with a polymerizable resin. The units may then be encapsulated by potting, casting, moulding, or dip-coating. The following impregnation sequence with a typical impregnant* and the examples of encapsulation processes illustrate current solutions of insulation problems in the production of high specification capacitors.

Vacuum impregnation

1. Arrange units to be processed as a batch on racks, suspending them by their leads and at a uniform height. Position rack in vacuum chamber so that impregnant will amply cover the windings.
2. Dry units by heating the chamber (250°F.) under vacuum below 0·1 mm pressure for about 16 h.
3. Prepare impregnant. This is done by mixing 1% by weight of Catalyst #10 into the required amount of Stycast 62.
4. Turn off heat on vacuum chamber and allow to cool to room temperature. Keep vacuum applied.
5. Admit impregnant (Step 3) to cover the units to the desired depth, maintaining the vacuum.
6. Hold under vacuum for ½ h. Adjust vacuum so that

*** Emerson & Cuming, Inc. solvent-less aromatic hydrocarbon formulation, viscosity 0·9 centipoise at 25°C. Storage life of the catalyzed resin is one week at room temperature, longer if refrigerated. (Note: Trade names throughout are Emerson & Cuming, Inc. products unless otherwise designated.)**

impregnant boils slowly. The vacuum line should have a cold trap kept at about −65°F. close to the chamber to prevent fouling the line or pump.

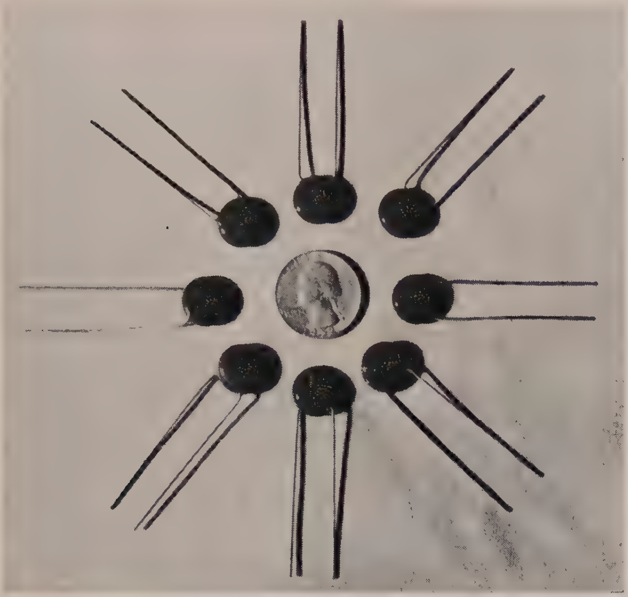


Fig. 1. Titanate ceramic disc capacitors, encapsulated by dip-coating in Eccocoat D-30, are rugged and perfectly sealed against moisture penetration.

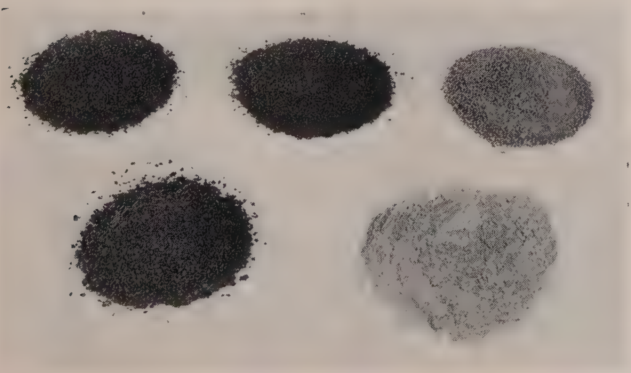
7. Break the vacuum. Keep units immersed in impregnant at atmospheric pressure for at least 2 h.
8. Remove rack with units from the chamber. Let drain for a few minutes.
9. Cure in circulating air oven at 85°C. for 10 h.

The now solid windings are ready for encapsulation.

Dip-coating

The main features of the dip-coating process (Fig. 1) are simplicity, low equipment and processing costs, flexibility, and adaptability to batch and automatic production methods. Dip-coats conform to the contours of the unit, thus affording space and weight savings over conventional rectangular or cylindrical castings as well as the electrical advantages of uniform thickness of the encapsulating dielectric. Several types of dip-coating formulations are available. They include adjusted viscosity dipping resins, thixotropic dip-coating compounds, and hot-gel types. A hot-gel modified epoxide formulation (Eccocoat D-30) was selected to meet specifications in the following example.

Fig. 2. Epoxy moulding compounds in their dry, granular form.



An insulating and processing system for volume production was designed for high electrical specification, mylar film, and wound capacitors—the finished package to be rugged, and of minimum volume. The temperature specification was 250°F. Dip-coating in hot-gel epoxide after impregnation with low loss polymerizeable hydrocarbon resin met all requirements. Units were processed in batches of twenty, and were handled from impregnation through the final cure of the dip-coat without removing them from the supporting rack. A single dip gave the necessary 20 mil thick coating. The impregnated solid units were heated to 300°F, dipped at the rate of 1/2 ft/min., with a 30 s interval before starting withdrawal. The tank was vibrated on a mechanical vibrator during the dipping operation. A few seconds drainage and an oven cure for 4 h at 300°F completed the process. Specific properties of the D-30 encapsulant, namely, outstanding adhesion to impregnant and to metal leads of the element, superior moisture-resistance, low vapour transmission, and resiliency to absorb thermal and mechanical shock contributed to the successful solution of this insulation problem.

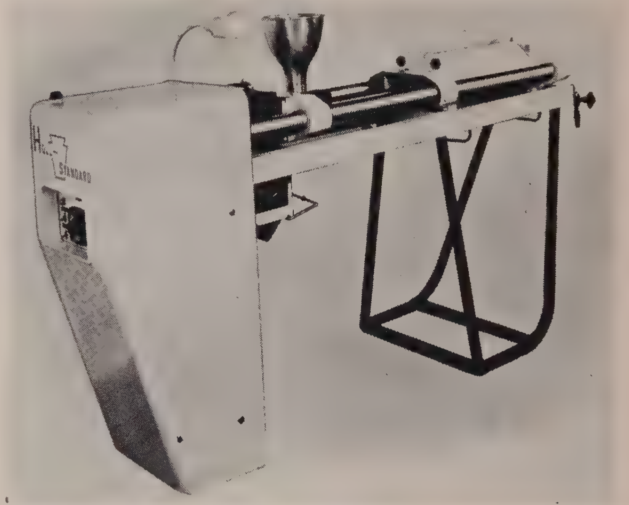
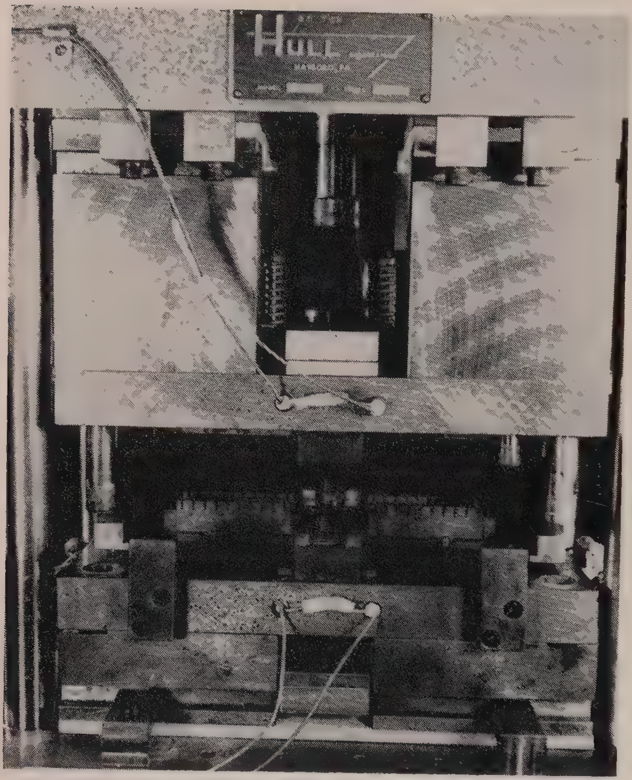


Fig. 3. Horizontal transfer moulding press for small electronic components.

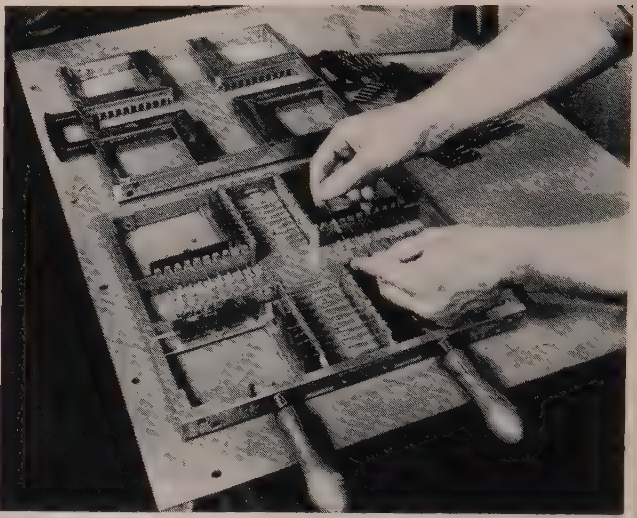
Transfer moulding

Direct encapsulation of small components by transfer moulding techniques is now possible. Sparking this advance has been the development of epoxy transfer moulding powders (Fig. 2) and of automatic equipment for low- and moderate-pressure transfer moulding (Figs. 3, 4). The use of lower pressures broadens the application of compression moulding into the area of fragile units and epoxy formulations make available, for application by this technique, some of our best and most versatile encapsulants. Transfer moulding is the method of choice where the number of parts to be run is high and the unit can be designed so that moulding pressures will

FIGURE 4. DIRECT ENCAPSULATION BY TRANSFER MOULDING



(a)



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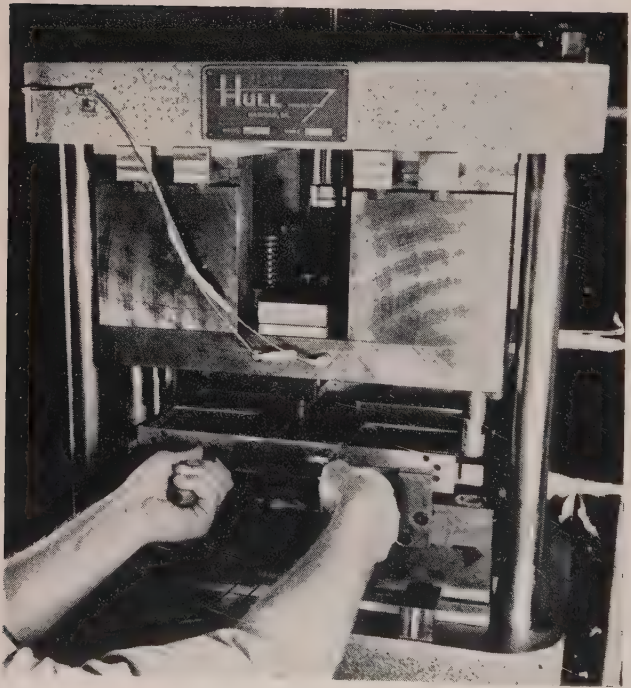
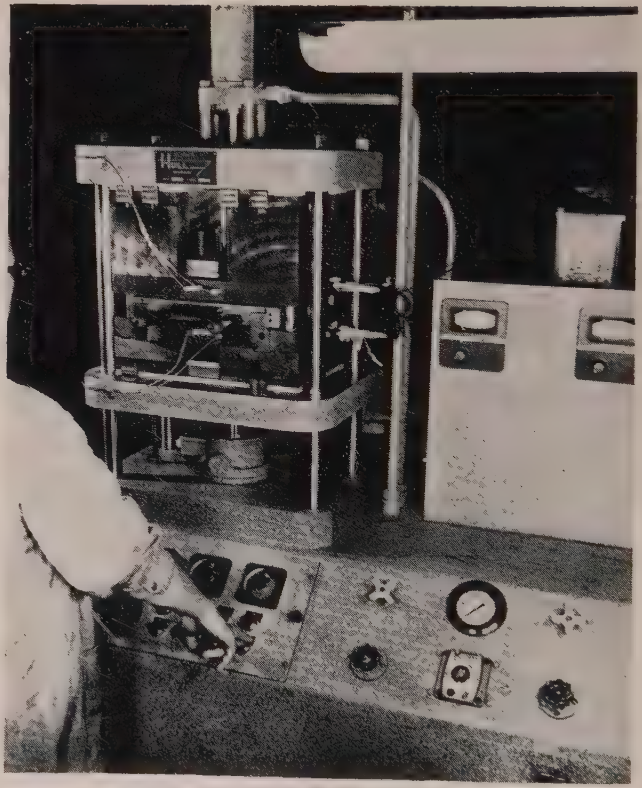


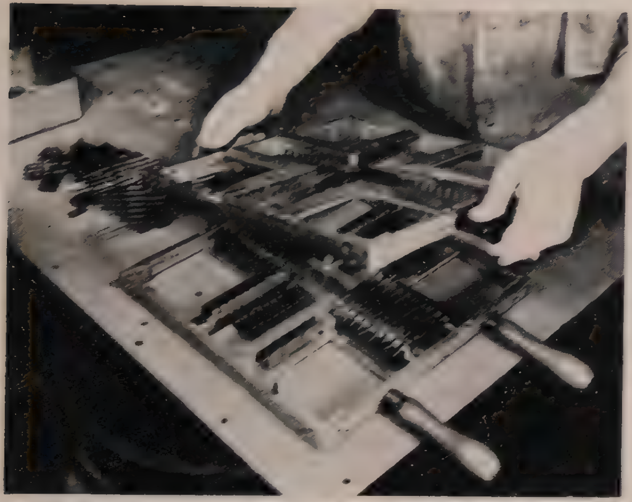


(d)

Fig. 4. Procedure for direct encapsulation by transfer moulding. Forty-cavity mould for encapsulating mylar-wound capacitors. The encapsulating material is a dry epoxy moulding compound and the overall cycle is approximately 2½ min. Other applications are: resistors, delay lines, transformers, chokes, diodes, vamistors, modules, and wire-wound coils. (*a*) Mould open, front view; (*b*) Load capacitors in frame; (*c*) Place frame into mould; (*d*) Actuate cycle buttons; (*e*) Remove loading frame after cure; (*f*) Check units; (*g*) Remove upper part of frame; (*h*) Break off runners.

(*Courtesy of Hull-Standard Corporation, Hatboro, Pennsylvania, U.S.A.*).

(e)

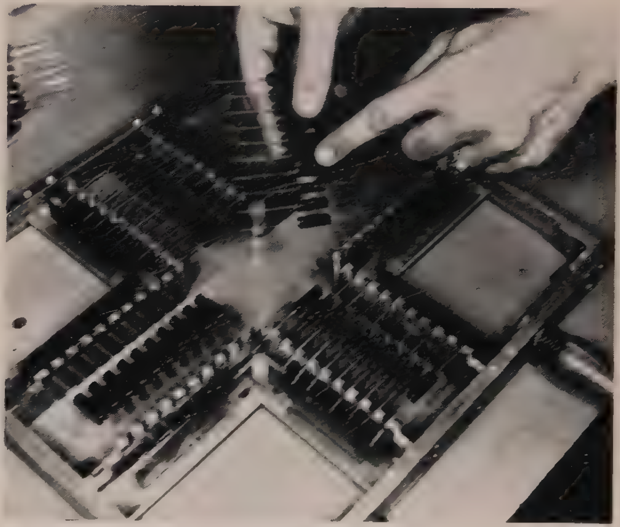


(g)

not damage the component.

The procedure for the encapsulation of mylar-wound resin impregnated capacitors by transfer moulding is described in Figure 4. A polished chrome-surfaced 40 cavity mould, used with a 25 ton, semi-automatic moulding press, produces 2,000 finished units per 8 h day on an overall cycle of 2½ min. The encapsulant is a self-releasing dry epoxy moulding compound and a transfer plunger pressure of 1,175 lb. in.^{2} at the plunger head was used. Pressure on the individual element in each cavity during processing is lower than the plunger head pressure, and distortion of the unit and damage to thin wire leads is thus prevented.*

(f)



(h)

New approaches

Liquid dielectrics, such as mineral oil, are still widely used as insulation systems for capacitors and filter circuits. Advantages of such systems lie in the low cost of materials and simplicity of processing. Impregnation and filling are done in one operation in the housing which is part of the finished unit, and no cure is needed. Liquid impregnated and or filled components exhibit a high level of corona resistance.

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* Extremely delicate elements have been successfully processed by transfer moulding at much lower plunger-head pressures. These include diodes and rectifiers, deposited carbon and metal film resistors, and miniature wire-wound devices. Recently developed and now in use on a production basis is a process for the encapsulation of fragile diodes using very low viscosity epoxy transfer-moulding compounds at plunger-head pressures of 50 lb. in.^{2}

An attack on the particular problem of leakage in liquid-filled components has been launched by means of research on dielectric gels. Silicone fluids which polymerize to heat stable gels* have found an application in the potting of miniaturized circuits. Self-healing properties and ease of repair permit the electrical check of elements and easy replacement of defective or failing parts. In development by Emerson & Cuming Inc. at the time of writing are chlorinated hydrocarbon gel-forming resins of interest in the potted capacitor field (Fig. 5). Favourable electrical properties of these resins are low dielectric loss, and higher dielectric constant than either mineral oil or the usual solid dielectrics. The gel form solves the problem of breakdown in service due to leakage, especially from accidental puncture or rupture of the housing and excellent corona resistance is anticipated.

Resistors, diodes and transistors

Dip-coating with thixotropic or hot-gel resins and low-pressure moulding processes are finding an increasing number of applications for the mass production of high-precision resistors, diodes, and transistors. The impregnation step, of course, is omitted in processing this type of element. Compression moulding, with preformed plastic tablets or extruded putties, transfer moulding, and potting in plastic shells lend themselves to direct single-operation automatic processing for efficient high-volume production. Speciality plastics permit operation at service temperature ambients up to 500°F and provide complete protection against moisture penetration—even in an underwater environment. The embedment of Fig. 6 is typical. This precision resistor is moulded in Stycast 2662, an epoxide capable of 500°F operation. Special configuration of the moulding permits chassis mounting for efficient heat transfer from resistance element to heat sink.

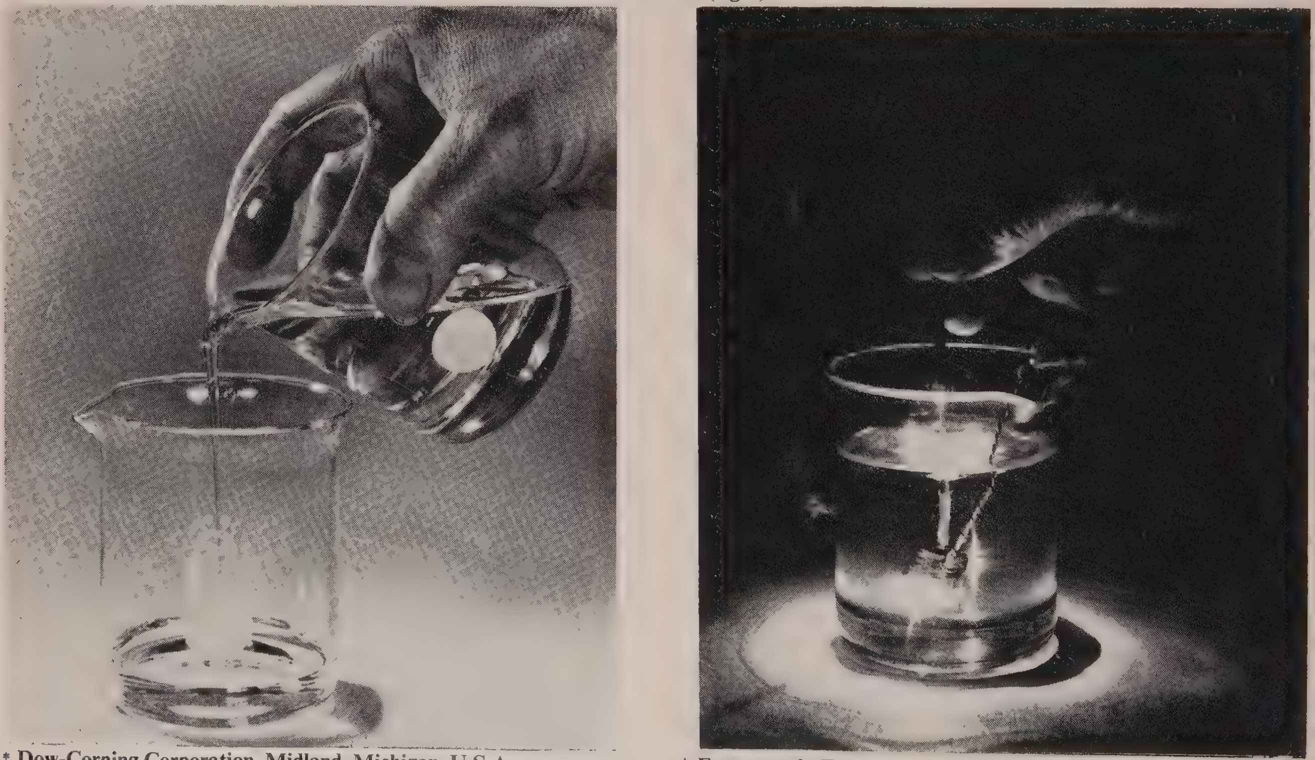
Transformers and coils

Heavy-duty service and applications in automatic control devices impose stringent requirements in the way of ruggedness, precision, reliability, and long life-expectancy. Process design for mass production is often involved as units may be destined for use in high volume markets such as the appliance field.

For impregnation of coil windings, low-viscosity solventless impregnants† and vacuum and pressure impregnation techniques are replacing solvent-diluted varnishes applied by dip or spray. In addition to giving improved electrical performance in the finished unit, the use of solvent-free resins makes it possible to impregnate and encapsulate in one operation.

Classical processes of potting, casting, moulding and dip-coating have been adapted and improved for use with modern encapsulants to provide specific solutions of insulation problems for inductors of all kinds. Plastic alloys and, in particular, epoxy-silicone formulations,‡

Fig. 5. Chlorinated hydrocarbon encapsulant pours as a liquid (left); cures to a self-healing gel for leak-proof pottings and easy check of electrical elements (right).



*** Dow-Corning Corporation, Midland, Michigan, U.S.A.**

† For example Eccoseal 1207, special formula epoxide impregnant.

‡ For example Eccosil 4520. This is an all-purpose compound, suitable for processing high requirement precision units by impregnation, potting, casting, or dip-coating.

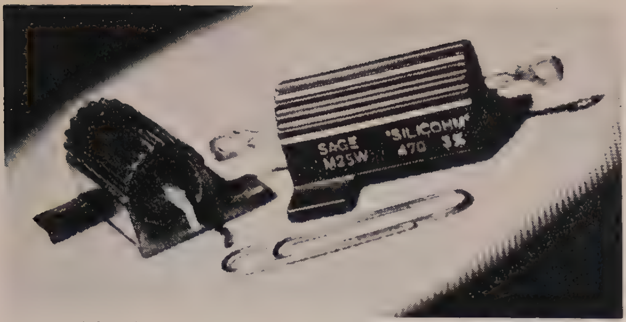


Fig. 6. Precision resistor moulded in Stycast 2662.
(*Courtesy of Sage Products Company, Rochester, New York, U.S.A.*)

are uniquely suitable for small transformer and heavy-duty coil insulation. They combine the best characteristics of both polymers, with elevated temperature stability and resilience over a wide temperature range of silicones and with superior adhesion, moisture-resistance, and outstanding electrical properties, at all frequencies, of epoxides.

The dual advantages of conformal encapsulation and potting can be obtained by the use of conformal moulding techniques.* In this method, the part itself is used as a die; a mould is formed about the part by draw-moulding thermoplastic sheet. Excess sheet material becomes a reservoir into which the encapsulant is poured to impregnate and pot. The mould and reservoir may subsequently be stripped from the unit after cure of the casting, or the reservoir only may be cut away for a potted unit.

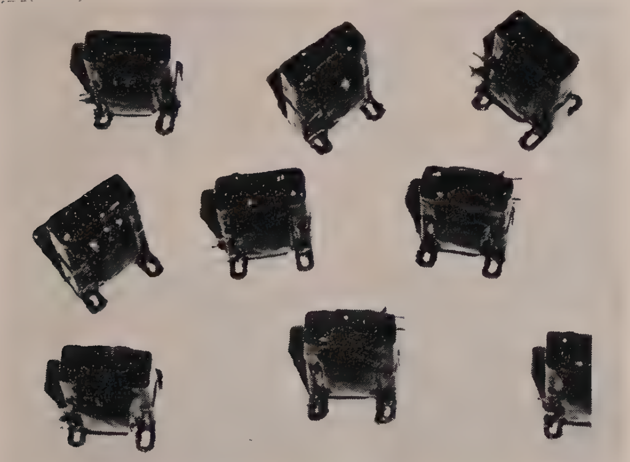


Fig. 7. Dip-coated transformers have improved moisture-sealing and heat dissipation properties.

The small transformers shown in Fig. 7 are batch processed by impregnation and dip-coating. Vacuum impregnation with Eccoseal 1207 followed by two dip-coats of Eccocoat D-30 gives a unified epoxy electrical insulating system. With their armour coats only $\frac{1}{32}$ in. thick, these units dissipate heat rapidly, and at the same time will stand up to high humidity and rugged service environments.

Cost was an important consideration in designing insulation and processing for a solenoid coil for regulating cyclic operations in a domestic appliance (Fig. 8). These units are now being mass produced by alternate vacuum and pressure casting in multiple-cavity moulds, using an automatic mixing-dispensing system to fill the moulds under vacuum. Evacuation and pressure are employed in this application to ensure adequate impregnation of the windings with the heavily filled encapsulant.† The coil forms are compression moulded phenolic plastic. The epoxy encapsulant has outstanding moisture resistance and also forms an integral bond with the coil-form plastic; thus the coil has a long service-life under conditions of immersion in detergent solutions.

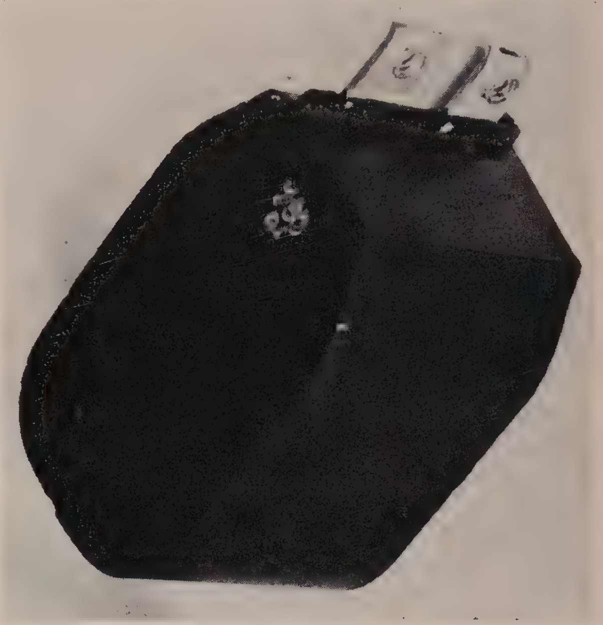


Fig. 8. Encapsulated solenoid coil is mass produced at rate of several thousand per day.

Miniaturized circuits

Horizons in the encapsulation of electronic circuits are limitless. Here, more than anywhere in encapsulation, each job presents unique problems, and today's happy solution is but the prelude to the greater complexities and more stringent specifications of tomorrow. Custom materials and custom processing are the rule, for these tiny circuits are composed of densely packed diverse electronic elements of high precision which must be effectively insulated from each other and from the environment by a minimum thickness of dielectric. High-frequency uses demand special dielectric as well as electrical properties in encapsulating materials. The two following examples of electronic circuit encapsulation illustrate the considerations involved in designing effective insulation for such systems.

As part of a programme to reduce the size of computer components, a transistorized gated flip-flop circuit

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*** Minnesota Mining and Manufacturing Company, St. Paul, Minnesota, U.S.A.**

† Stycast 2651MM, epoxide resin base.

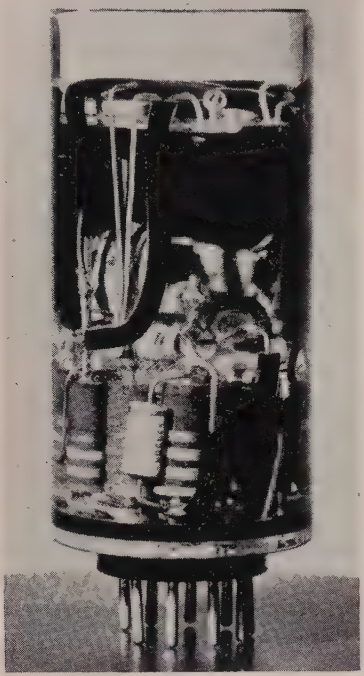

Fig. 9. High component density space-wiring technique is demonstrated in this gated flip-flop encapsulated in clear resin.

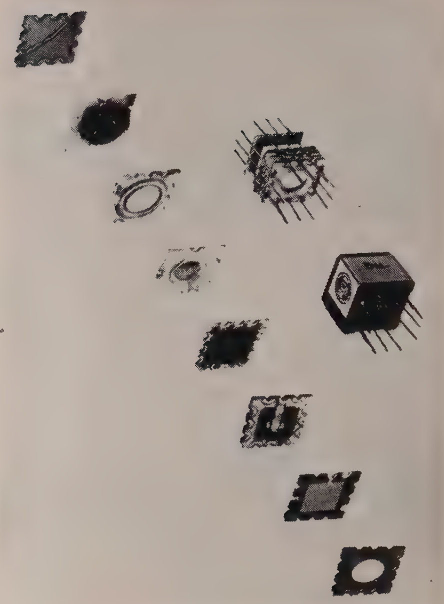

Fig. 10. Micromodule circuit; ceramic wafer block design for high parts-density package; Stycast 2651-40 encapsulant passes rigid military specifications.

was submitted for miniaturization. Printed-circuit techniques were first considered as the best hope for reducing the size, but the 3-dimensional cast unit, designed with free-space wiring, achieved an even greater overall reduction in size with no sacrifice of reliability (Fig. 9). The packaged circuit is $\frac{7}{8}$ in. in diameter and $1\frac{5}{8}$ in. high. It consists of eleven $\frac{1}{4}$ in. width resistors, four disc capacitors, four transistors and seven diodes mounted on a miniature plug-in base. A dielectric coating insulates all surfaces of all elements. Space design, placement of units, and encapsulation procedure were as follows.

All wiring was perpendicular to the base so that principal component faces could be positioned in the mould to allow the resin, in filling, to flow downward freely toward the plug-in base. The transistors were placed at the top of the unit, for this was to be the coolest part of the completed unit.

The four transistors were first cast together, as a module, using epoxide resin of paste consistency. After all other wiring was completed, the block of transistors was placed at the top of the unit, leads up, and the leads brought out and down to the proper points. The units were cast, terminals up, in cylindrical moulds, in filled epoxide encapsulant.* An extremely rugged package with good heat dissipation characteristics was achieved.

A 0·310 in.^{2} ceramic wafer is the basic design unit for ultramicro electronic circuits in block form, as developed by Radio Corporation of America (Fig. 10). The wafer, usually made of alumina, serves as a mounting platform or base for miniature circuit elements, such as capacitors, transistors, resistors, and ferrite-core inductors. Circuit elements are applied to a series of wafers, which are then stacked to form the module. Twelve notches around the periphery of each wafer provide for interconnections between elements, and for lead wires coming out at one end. The stack is finally encapsulated, producing a standard-size square-block module 0·350 in. on a side. Component densities of several hundred thousand per cubic foot are achieved. Fig. 10 shows individual wafer elements, stacked assembly, and the encapsulated finished circuit. The elements, in order, are: end wafer, ceramic capacitor, electrolytic capacitor, resistors, diode, transistor, inductor plus capacitor, and end wafer with hole. Epoxide resin Stycast 2651-40 is the encapsulant. Kits are available from the Radio Corporation of America for manufacturers who wish to design their own circuit modules based on ceramic wafer units. These contain completed ceramic wafers and all apparatus required to build circuits by designers of space probes and orbital packages, small digital computers, miniaturized communications equipment, etc. Finished units can be produced to meet rigid military specifications for moisture resistance, thermal, mechanical, and altitude shock.

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(3) *Methods and Equipment for Mixing, Metering, Dispensing, and Moulding Epoxies.* By John L. Hull. **Insulation,** July 1960.

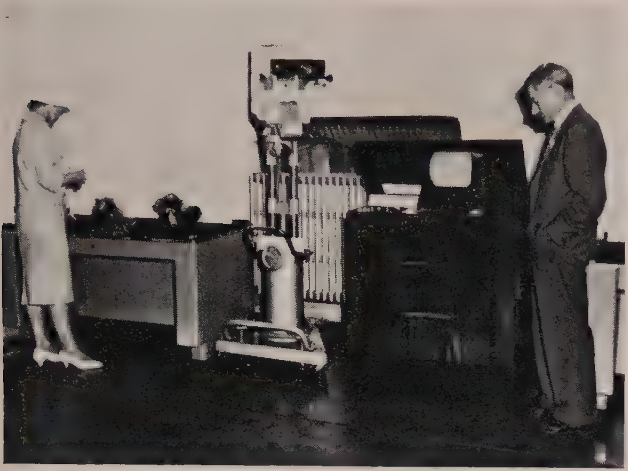
(4) *Encapsulating with Plastic Shells Simplifies Potting Process.* By Milton Ross (The Milton Ross Company, Hatboro, Pennsylvania). **Electronic Design,** November 23rd, 1960.

(5) *Ceramic Wafers: Base Materials for Electronic Units.* Radio Corporation of America, Semi-conductor and Materials Division (Somerville, New Jersey, U.S.A.). **Ceramic Age,** February 1961.

*** Stycast 2651 (Note: The casting of Fig. 9 was made with clear resin to show internal design).**

Television Silver Jubilee

Isaac Shoenberg and Other Pioneers at E.M.I. Reception



Visitors at the reception inspect the first television camera tubes, one of the original B.B.C. cameras used in 1936, and a 1937 receiver.

TELEVISION as we know it is 25 years old this year—thanks largely to Isaac Shoenberg and his brilliant team of research workers at the Hayes laboratories of Electric & Musical Industries Ltd. in the early 1930's.

To mark this anniversary, the Press was invited to meet Mr. Shoenberg and some of his fellow pioneers in E.M.I.'s Research Building, where most of the early development work was carried out.

There are now 100 million television receivers all over the world and new transmitters are opening every month, but in 1936, when the B.B.C. first transmitted regular public high-definition television programmes, only 50 receivers existed. These were lent to employees of the few organizations in the television industry, to test reception in the London area.

It is not generally realized that the electronic system of television then used was the one developed by Mr. Shoenberg and his team. That system forms the basis of television as used throughout the world today, and the 405-line standard, which Shoenberg courageously adopted at a time when a much lower number of lines was considered to be sufficient, is still used in Britain.

The first television camera tube, an early camera and a 1937 television receiver, which showed the picture reflected in a mirror in the raised lid, were among several interesting items of equipment exhibited during the party, and the prototype aerial mast for the one subsequently erected at Alexandra Palace still stands in the grounds adjoining E.M.I.'s Research Building.

An impressive working demonstration was given of E.M.I. Electronics Ltd's. latest colour television system, which is being widely used industrially in this country and overseas.

History of Early Developments

When Isaac Shoenberg and his team started work on television development in 1931, the only kind of television which existed was a crude mechanical system operating on 30 lines. Shoenberg decided that, if television was to become a public success, a much higher definition picture would be necessary and he started to tackle the difficult problems involved.

The first problem arose out of the scanning of a larger number of lines. With the mechanical type of scanners of that time, a large increase in the number of lines was practically impossible, because of the mechanical difficulties and the excessive amount of illumination that would have been required. Campbell-Swinton had indicated as early as 1908 a possible electronic solution to

Isaac Shoenberg speaking at the reception.

Dr. L. F. Broadway, Director of the E.M.I. Research Laboratory.

this problem but the means for carrying it out did not exist at that time. In 1931 it seemed possible that the Campbell-Swinton idea might be put into practice, and the E.M.I. team made the attempt. This led to the development of the Emitron electronic camera tube.

Yet another problem arose in connection with the receiver. The only possible way of producing a satisfactory high-definition picture was to use a cathode-ray tube. At that time, the cathode-ray tube was an expensive specialized tube only found in scientific oscilloscopes. Moreover, it relied upon gas focusing, and, remembering the trouble he had had with the early soft valves, Shoenberg advocated a hard tube. The outcome was a new type of cathode-ray tube with a good focus, designed to be capable of mass production at reasonable prices, which transformed the laboratory tube into something suitable for the home television receiver.

It was soon clear that high-definition pictures could never be transmitted on medium waves because the bandwidth required would be too great. It was necessary to move to short waves and this aroused much opposition because it was argued that the range of the transmitter would be greatly restricted. Nevertheless, Shoenberg persisted in this policy and enlisted the help of the Marconi Company to provide a short wave transmitter. A transmitter was installed on the top floor of the Research Building and the aerial was erected on an adjacent mast. Much work had to be done to adapt this equipment to make it suitable for radiating high definition pictures.

In addition to these problems, there were many others to be solved on the circuit side. The objective was always to put the complication into the transmitter as far as possible, so that the receivers would be simple and therefore cheap and reliable.

When the complete system was taking shape in 1934/35 and Mr. Shoenberg was giving evidence before the Television Committee appointed by the Postmaster General, the time came to finalise the specification for the E.M.I. system and in particular settle the number of lines in the picture. He finally decided to adopt 405 line definition which stretched the transmitter's capabilities to the limit. He realized that the receivers of that time could not do full justice to this high-definition standard but he thought it best to set a high standard so as to leave room for improvements in the receiver for several years ahead without the disruption which would be involved by a change of line standard.

The report of the Television Committee was presented to Parliament in January 1935. It recommended that a television service should be started from London with two systems—those of Baird on 240 lines and E.M.I. on 405 lines (interlaced)—operating alternately from one transmitting station.

This recommendation was adopted and experimental public transmissions by both systems radiated by the B.B.C. from Alexandra Palace during the Radio Exhibition at Olympia in August 1936. The transmissions were then discontinued until October when a series of trial programmes was radiated for two hours daily.

The London Television Service from Alexandra Palace was formally opened by the Postmaster General on 2nd November, 1936, with a public service for two hours daily. The two systems were used during alternate weeks.

On 5th February, 1937, the Postmaster General announced that, as a result of the experience gained, the Television Advisory Committee recommended that henceforth only the E.M.I. system should be used. This recommendation was put into effect on 6th February and, apart from the interruption during the war years, Shoenberg's system has been used by the B.B.C. ever since.

Isaac Shoenberg

Isaac Shoenberg, M.I.E.E., is a director of Electric & Musical Industries Ltd. and adviser to the E.M.I. Board.

He was born in Pinsk, Russia, in 1880, and studied mathematics, mechanical engineering and electricity at the Technological Institute of Kiev.

After taking his degree, he joined a Russian company and was responsible for research, design and installation of the earliest wireless transmitting stations in Russia.

In 1914 Mr. Shoenberg settled in England and worked for the Marconi Company, becoming a British subject in 1919. He joined the Columbia Graphophone Company as General Manager in 1928 and, when that Company merged with the Gramophone Company in 1931 to form Electric & Musical Industries Ltd., he became Director of Research.

Mr. Shoenberg led the team of scientists and engineers which developed the 405-line electronic television system used by the B.B.C. in 1936 for the world's first regular public high-definition television service.

TRANSISTORS OR VALVES?

A Survey of Their Relative Merits for Electronic Instruments

BY G. F. PENVER
Chief Engineer
(Instruments Division)
Advance Components Ltd.

WHEN the transistor was first introduced to engineers it was met with the same sort of reserve with which one first greets one's prospective in-laws. They were prepared to be open-minded about the device, yet were full of suspicion of this new, radically different and as yet unproved component. Considering the promise offered by the manufacturers, transistors were slow starters, but their use gained momentum when engineers adapted their thinking. They became familiar with their usage, and the earlier promises were quickly realized. However, no doubt hypnotized by the degree of miniaturization possible and the fantastically low power consumption of the device, the electronics industry embarked into the glamorous era where the first question asked of any new equipment was "Is it transistorized?" Now the glamour has worn thin, the merits of the transistor are in the right perspective and circuit designers no longer ask of themselves "Can we use transistors?" but "Which are better for this application, transistors or valves?"

The low power consumption of transistors is admirably suited to battery operated apparatus but batteries are the most expensive way of providing electrical power (£5 per unit is a conservative estimate). Dry batteries have a habit of giving out when most required and rechargeable batteries require an effort of memory on the part of the engineer to ensure that his equipment is kept at peak performance. With many transistorized instruments the provision of a pilot lamp demands a higher power consumption than the equipment. Some apparatus, which require voltages higher than the battery voltage and employ transistor converters, are fitted with a flashing neon lamp as the indicator. This has the dual advantage of being very economical in power requirements and considerably more obtrusive than the conventional pilot lamp. These instruments however, are the exception rather than the rule and, in general, all instruments tend to remain "switched on" when not in actual use, to the detriment of batteries.

There are very few circumstances, with the possible exception of Service and G.P.O. applications, where battery operation is an absolute necessity and the importance of this facility is usually grossly over-rated. Battery operation can be, from the instrument manufacturer's point of view, a matter of economics. The provision of a mains supply unit in some simple instruments could double the selling price. There is also a distinct virtue when battery-operating some instruments, such as l.f. oscillators and millivoltmeters, in the freedom from hum.

The transistor really comes into its own in computers, and such instruments as electronic counters, where miniaturization and heat dissipation are conflicting requirements. Here, with the multiplicity of dynamic circuit elements demanding the highest reliability, it is the qualities of ruggedness, freedom from microphony, and the potentially longer life of the transistor which are most desirable.

Cost is no longer significant—in most l.f. applications the merits tend to be in favour of the transistor, but in the high frequency field the transistor has a long way to go before it is likely to be preferred to the valve in both cost and performance.

In instrumentation, temperature stability and uniformity of gain from element to element are a good deal more important than, say, in broadcast receivers but we find even receiver manufacturers buying transistors in matched sets. Special precautions are necessary in both fields to preserve temperature stability. If one does not wish to select transistors to achieve a certain gain in an amplifier it is usually necessary, due to the very wide spread in transistor characteristics, to design for the worst condition and employ rather more circuit elements than would otherwise be necessary. It is also necessary to give a very much wider range of adjustment than would be necessary with valves. One virtue of the transistor well worth mentioning is its improved linearity when employed in amplifier circuits; harmonic distortion can be kept very low even in single-ended circuits.

If the electronic counter represents the very best usage of the transistor, the signal generator could well represent the very worst, unless a hum-free output or low harmonic distortion are over-riding factors. The small number of valves that the transistors are replacing result in a barely noticeable reduction in dimensions unless miniaturization with all the other components is also carried out. While on this subject, is it broaching too controversial a topic to suggest that the reliability thus gained on the transistor swings is then lost on the component roundabouts?

Miniaturization in instruments can be carried too far and the front panel of any instrument cannot be reduced in area below that of a reasonably readable meter scale or frequency dial, and as for the other controls, until nature endows us with miniature fingers, these still need to be the same size. Also, with increasing circuit complexity, they require more coding information—not less. Saving in front panel space can be effected for some increase in cost, by using drum-type meters and film drive frequency scales. Since the meter manufacturers appear to have successfully interchanged the needle and the scale in the new digital projection indicators, would it be reasonable to anticipate a very great saving in front panel space by the use of projection meters?

As every circuit designer knows, transistors require power from the input signal while a valve requires a voltage only. The loading of the transistor on the frequency determining networks of, say, an r.c. oscillator are a distinct inconvenience in that with the low-impedance networks then required, it is necessary to employ variable resistors instead of variable capacitors. Unless individual frequency calibrations or a special accurate variable resistor is employed typical calibration accuracy obtained is ±3% instead of the usual ±1%—surely a retrograde step which is hardly outweighed by the advantages obtained.

Obviously the transistor must be considered on its merits like any other circuit component and providing the ambient temperature is not grossly elevated by the use of valves there appears to be no objection to the use of both in the same instrument. Indeed, this has been seen in some oscilloscope circuits.

In conclusion it appears that the valve is far from defunct, although it is fighting a losing battle, for the field effect transistor will undoubtedly take over eventually in many of the remaining applications for which the valve is currently best suited.

The last bastion of the valve to succumb will probably be in the signal power field. The best feature of the transistor is its small size but this, coupled with the temperature limitations, makes it a poor choice for power applications. The size of the cooling arrangements necessary leaves room for doubt as to whether any miniaturization has been achieved. We are all aware of the work that is being carried out on Peltier effect cooling devices but in view of the cost, does this particular quart have to go into a pint pot?

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IMPROVING PERFORMANCE OF MICROWAVE RECEIVERS

Continued from p. 678

bandwidth of 100 Mc/s at a 400 Mc/s signal frequency, with a pump frequency of 900 Mc/s and a pump power of 10 mW. This experimental amplifier has a gain of 10 dB and a noise figure of only 3½ dB.

A single type of diode can be used to make an amplifier for any desired frequency from the high microwave region down to d.c. The noise performance improves rapidly as the frequency decreases from microwaves down into the u.h.f. region, thus making such an amplifier potentially useful for u.h.f. television receivers.

Interesting aspects of the diode amplifier are its simplicity and potential reliability. Major components are the proper waveguide structures, the diode itself, and a suitable pump signal source. It appears that these components can be assembled to provide a relatively inexpensive device. No refrigeration is required, and no magnetic fields are necessary. The low-noise characteristics can be realized at room temperatures.

Although the variable capacity effect is present in commercial diodes, Bell Laboratories' scientists have developed, under a U.S. Signal Corps contract, special diffused silicone diodes to maximize this effect. Series resistance, which could be a source of noise, is minimized in these diodes. Units fabricated by N. G. Cranna of Bell Laboratories have an active diameter of about 0·002 in.

The development of the varactor diode amplifier holds promise of providing a whole new family of low-noise amplifiers for the u.h.f. and microwave frequency ranges. These devices will complement the semiconductor diode up-converters, which can also provide low-noise amplification.

Impact Extrusion of Transistor Bases

By J. S. Waite, B.Eng., G.I.Mech.E.

Development Engineer, Floform Parts Ltd.

Floform Parts Ltd., jointly owned by Steel Industries Incorporated of U.S.A. and Guest Keen & Nettlefolds Ltd., was established early in 1960 to manufacture bases for the semiconductor industry. This article describes the design of such components, and the manufacturing methods developed and used by Floform Parts Ltd.

Product Requirements

THE main requirements of a mounting base for a power transistor or semiconductor rectifier are high thermal conductivity of the base material, together with a high degree of surface flatness and smoothness on critical surfaces, particularly the underside. This ensures maximum dissipation of heat from the device to the chassis on which it is mounted in service. The bases must also be manufactured to a high degree of dimensional accuracy to enable subsequent mounting and assembly operations to be performed on automated equipment.

The first choice of raw material is normally copper, and as many of the bases are annealed during manufacture or brazed in a reducing atmosphere during assembly, oxygen-free high-conductivity copper is usually specified; this quality of material eliminates the risk of hydrogen embrittlement during any subsequent furnace operations. However, the poor machining characteristics and very high price of o.f.h.c. copper make it unsuitable for conventional machining operations because it gives very poor tool life, and a large amount of expensive material is unavoidably wasted in turning.

A better way of manufacturing such parts is by cold forming, which gives more freedom of shape to the designer, greater economy of material, improved surface finish to the part and often higher production rates than conventional machining operations allow. The advantages of this method are greatly emphasized in large quantity production where the higher initial tool costs can be offset against the overall economies made.

Product Design for Cold Forming

Cold forming is a term embracing cold heading, coining and impact extrusion employed in carefully chosen combinations in accordance with the design requirements of the particular component. Consultation at the design stage between the transistor designer and the component supplier is essential to achieve a final design which fully satisfies the designer's requirements (and these often include features impossible to obtain by conventional machining methods) yet enables economical manufacturing methods to be used by the component supplier. Often a fabricated assembly has been replaced by a one-piece cold-formed part. Similarly, a part which previously needed many machining operations can be cold formed in only one operation. However, tooling stresses and material flow behaviour can set certain limitations on the design of the part, but with co-operation at the design stage these can be taken into account and unnecessary subsequent operations avoided.

It is also necessary to agree the manufacturing tolerances at the design stage, for these directly affect both the cold-forming techniques used and also the life and adjustment of the tools. For these reasons manufacturing costs are related to the closeness of the tolerances required and although cold formed parts are more consistently maintained within the required limits than machined parts, tolerances should not be specified to closer limits than are really necessary.

Manufacturing Methods

Typical examples of production sequences are illustrated.

Figs. 1 and 2 show stages in the manufacture of bases which have thin flanges for final encapsulation of the device. As this operation causes some distortion of the flange, two designs are adopted to prevent distortion of the base as a whole. The first method is to raise the flange from the level of the base; the second is to keep the flange at the same level as the base but to provide a circumferential groove which accommodates any distortion of the flange. The latter gives a more compact design but demands a manufacturing method different from the former.

The first manufacturing stage with both types of component is the production of an extrusion blank of the correct shape and volume. This can be done by blanking from strip or sheet, machining from bars on an automatic lathe, or cropping from a bar. Whichever method is used however, it is necessary to produce a blank with a good surface finish and free from any cracks. After blanking, the slugs are annealed in a reducing atmosphere in a continuous furnace, before being tumbled in a suitable lubricant in readiness for the main cold-forming operation. The amount of lubricant must be carefully controlled to avoid undue tool wear, or poor surface finish or bad definition due to excess lubricant trapped in the die.

The second stage is the cold-forming operation. The component shown in Fig. 1 involves a backward extrusion, while that shown in Fig. 2 has been produced by a coining or spreading operation. In both cases the tool loading is very high (approximately 100 tons/in^2) and careful tool design is essential to avoid tool breakage, particularly where the design of the base incorporates such features as a plinth on which the silicon or germanium crystal is mounted. These features can cause very high local stresses in tools.

After the principle cold-forming operation has been performed, subsequent flanging, trimming and piercing operations may be required, and it may be necessary to counterbore or deburr pierced holes.

Slightly different methods are used to produce semiconductor rectifier studs. Although small quantities of studs can be made by conventional machining methods, low material utilization and the poor machineability of o.f.h.c. copper make it an expensive process. However, where design has been stabilized and larger quantities justify the initial expense of extrusion tools, rectifier studs may be produced either from wire by cold heading (Fig. 3) or by combined forward and backward extrusion (Fig. 4). In both cases the thread is then rolled on the shank.

Often it is necessary to braze a steel ring into the head of the stud for a projection welding operation at a later stage in the manufacture of the rectifier. Brazing would then be performed before the thread rolling operation to prevent reduction in thread strength by annealing during brazing.

At each stage during manufacture careful statistical quality control is applied to maintain the high degree of accuracy required. Good design of tools and careful selection of equipment will minimize random variations, but wear and possible failure of tools must be continuously guarded against.

Equipment

The cold-forming equipment installed at Floform Parts Ltd. ranges from 30 ton crank presses for preparation of blanks, to 150 ton hydraulic and crank presses for coining and extrusion. In addition, a variety of small presses of up to 4 tons are used for marking and light forming operations. Other equipment includes cold-heading machines, thread-rolling machines and precision drilling machines with automatic-feed attachments. A conveyor furnace with ammonia cracker is used for annealing and brazing operations in a reducing atmosphere.

Conclusion

Although Floform Parts Ltd. concentrate their activities, at present, on bases and cans for the Semiconductor Industry, there are many other components for other industries which could be made more efficiently and economically by the techniques outlined above. Knowing the costs of production by conventional machining methods, it is a relatively simple exercise to determine whether production is more economical by cold forming, taking into account the probable total volume and initial tool costs with lower material and conversion costs of cold formed parts.

FIG. 1

FIG. 2

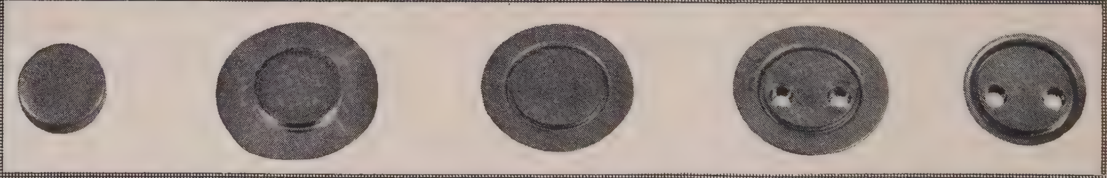


FIG. 3

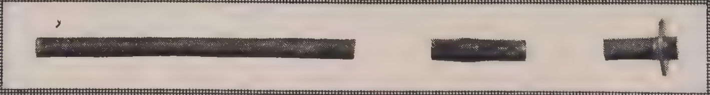
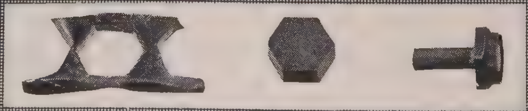


FIG. 4



CALIBRATION OF WAVEGUIDE REFLECTORS

In the Microwave Frequency Region

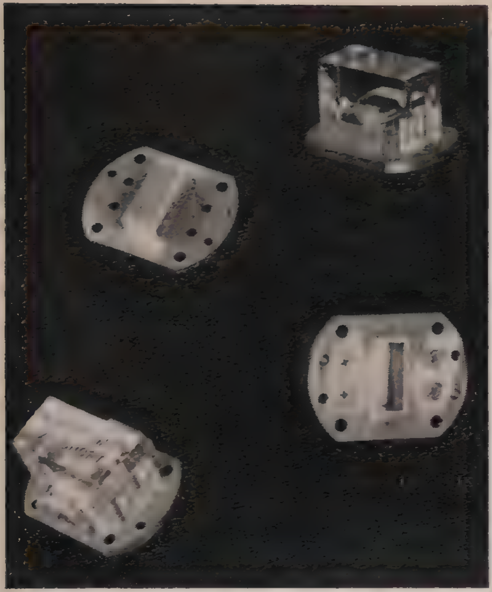


Fig. 1. Precision quarter-wavelength short-circuit standards against which inter-laboratory standard reflectors are calibrated.

A MODIFIED REFLECTOMETER SYSTEM

Calibration of waveguide reflectors in the microwave frequency region is currently being conducted at the Electronic Calibration Centre of the United States National Bureau of Standards' Radio Standards Laboratory, Boulder, Colorado. (WR-90 waveguide size throughout the frequency range 8·2—12·4 Gc/s.)

High accuracy is obtained through the use of a modified reflectometer system. The waveguide reflectors are calibrated by comparison with a working standard employing a straightforward method that can be adapted for use in other standards laboratories.

IMPEDANCE in microwave circuits is often not uniquely defined. However, the behaviour of propagating waves can be determined in terms of two waves travelling in opposite directions. A wave incident upon an arbitrary change in an otherwise uniform transmission line results in a reflected wave, the relative magnitude and phase of which are determined by the nature of the change. The ratio of the reflected wave to the incident wave at a given reference plane is termed the reflection coefficient. The two opposite-travelling waves also interfere with each other to form a standing-wave pattern. For voltage waves, the ratio of the maximum amplitude to minimum amplitude of the standing wave is called the voltage-standing-wave-ratio (v.s.w.r.) and is linearly related to the voltage reflection coefficient magnitude. The calibration system in use at the National Bureau of Standards is designed to measure accurately the magnitude of the voltage reflection coefficient for the dominant mode of propagation.

Devices designed to effect a standard value of reflection coefficient are termed reflectors. They are sometimes called standard reflections or standard mismatches. Reflectors currently being manufactured for rectangular waveguide are generally of the fixed type, and a separate reflector is needed for each value of reflection coefficient. The reflection is usually accomplished by a change in one of the inside transverse dimensions of the waveguide at the plane of the mounting flange. In most such reflectors, the smaller dimension of the waveguide is made to be less than the same dimension for a standard size waveguide. The reflector contains a low-reflection absorptive element provided with means for sliding it along the axis of the waveguide to permit the averaging out the reflected signal from the absorptive element. A typical set of waveguide reflectors for a given waveguide size consists of five reflectors with nominal v.s.w.r's. of 1·05, 1·10, 1·20, 1·35, and 1·50. Corresponding reflection coefficient magnitudes are approximately 0·025, 0·05, 0·09, 0·15, and 0·20.

Many standards laboratories maintain a set of reflectors for each of the common waveguide sizes. These reflectors are used to calibrate microwave impedance measuring instruments such as slotted lines and reflectometers.

The surface of the waveguide flange of reflectors are inspected for flatness and freedom from nicks and scratches. Since the reflector must be attached to a precision waveguide section incorporated in the calibration equipment, such defects might damage the precision section and are cause for rejection. If the mounting flange surface of the reflector is suitable for connection to the calibration equipment, it is checked electrically

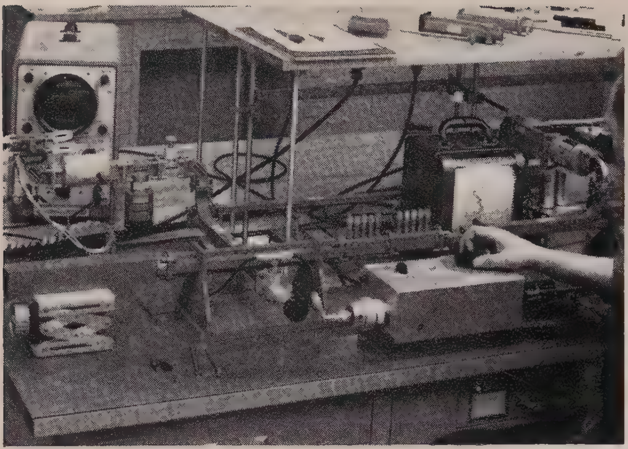


Fig. 2. N.B.S. staff scientist adjusting a precision variable attenuator developed at the Bureau and used to calibrate inter-laboratory standard reflectors against working standards. The inter-laboratory standard is supported by the laboratory jack at the lower left.

MICROWAVE IMPEDANCE CALIBRATION IN WR-90 WAVEGUIDE

Nominal value		Accuracy of calibration (%)
v.s.w.r.	Reflection coefficient magnitude	
1·05	0·025	1·5
1·10	0·05	1·5
1·20	0·09	1·0
1·35	0·15	1·0
1·50	0·20	1·0

for variations in the reflection coefficient due to the following:

1. Rotational movement of the sliding termination.
2. Transverse movement of the sliding termination.
3. Variations in successive maxima and/or successive minima obtained with the sliding termination.
4. Instability in positioning the sliding termination for a maximum or a minimum.
5. Variation in reflection coefficient between the two possible mounting positions of the reflector.

Reflectors exhibiting excessive variations in any of the above are not usually calibrated.

Using a modified reflectometer system, the reflection coefficient magnitude is determined with reference to the Bureau standards. The maximum and minimum reflection coefficient magnitudes are measured and the two results averaged to obtain the magnitude of the reflection coefficient due to the discontinuity at the flange. The working standards currently used are electroformed silver quarter-wave short circuits, the reflection coefficient magnitudes of which have been evaluated to an accuracy of ±0·05%.

References

Microwave reflectometer techniques. By G. F. Engen and R. W. Beatty, **I.R.E. Trans. on Microwave Theory and Techniques,** MTT-7, **No. 3,** p. 351 (July, 1959).

Recently developed microwave impedance standards and methods of measurement. By R. W. Beatty and D. M. Kerns, **I.R.E. Trans. on Instr.,** 1-7, **Nos. 3 and 4,** p. 319 (Dec. 1958).

TELCON PLASTICS LTD.

Development of Epoxy Resin Powders

WHERE high electrical insulant properties are required, together with resistance to heat as well as to moisture and other corrosive elements, the development of epoxy resin powders as a dip-coating medium continues to be of increasing interest.

Epoxy powders is one of the newer fields to which particular attention is being devoted by Telcon Plastics Ltd., a member of the British Insulated Callender's Cables Ltd. group of companies. In April last, Telcon Plastics took over the entire range of activities of the Plastics Division of The Telegraph Construction & Maintenance Co. Ltd., also a member of the BICC Group.

The coating obtained by epoxy resin powders has all the outstanding protective qualities of epoxies as applied by well-proved techniques. Among the advantages conveyed by fluidized bed powder coating as a method of application are speed and low wastage. One of the spheres in which the properties of epoxy resins are most advantageous is that of the coating of electrical and electronic apparatus, notably in the insulation of stators and other components of motors.

The ideal dip-coating medium combines toughness, good appearance, a high degree of chemical resistance, good electrical insulating properties, and the ability to withstand very high temperatures. Thermoplastics fulfil most of these requirements, but for resistance to really high temperatures it is necessary to consider thermosetting materials, and it is in this direction that the most interesting achievements may be anticipated.

Telcon Plastics Ltd. manufacture and develop all the plastic products with which the name Telcon has long been associated—the plastics coating of papers; mouldings and tubing; processed gutta-percha and balata; plastics powders for dip-coating and other applications; sheeting for vacuum forming and fabrication, and coated materials and laminates for use in specialized packaging.

Supplement to BUYERS' GUIDE

The following are additional entries and some corrections to the Buyers' Guide included in the May issue of *Radio & Electronic Components*.

ADDITIONAL ENTRIES

ANCILLARY DEVELOPMENTS LTD., Ancilco Works, Surrey Avenue, Camberley, Surrey. *Tel.*: Camberley 3443.

Products

- **Potentiometers**
    - helical
    - linear
    - logarithmic
    - low torque
    - precision
    - pre-set
    - sine-cosine
    - sub-miniature
    - trimmer
- **Resistors, Variable**
    - sub-miniature
    - wire wound

CLARKE, H., & CO. (MANCHESTER) LTD., Atlas Works, Patricroft, Nr. Manchester. *Tel.*: Eccles 5301.

Products

- **Board, Resin Bonded**
- **Bobbins**
- **Cores**
    - C-type
    - E-type
- **Extrusions**
    - plastic
- **Formers, Coil**
- **Group Boards**
- **Insulating Materials**
    - fabric
    - glass
    - glass bonded mica
    - laminated
    - mica
    - nylon
    - paper
    - plastic
    - rubber
    - silicone
- **Laminates**
    - asbestos
    - copperclad
    - corrugated
    - glass fibre reinforced
    - silicon-glass
- **Mouldings**
    - fibreglass
    - glass
    - glass bonded mica
    - nylon
    - plastic
    - rubber
- **Mounting Strips**
- **Plastic Materials**
    - nylon
    - polystyrene
    - polytetrafluorethylene (P.T.F.E.)
- **Plugs and Sockets**
    - printed circuit
- **Printed Circuits**
- **Sleeving, Insulated**
- **Stampings**
    - fibre
    - metal
    - plastic
- **Tapes**
    - glass fibre
    - insulating
- **Terminal Blocks**
- **Terminal Strips**

ELLIOTT BROTHERS (LONDON) LTD., Elstree Way, Borehamwood, Herts. *Tel.*: Elstree 2040.

Products

- **Attenuators**
    - decade
    - radio frequency
    - variable
    - very high frequency
- **Connectors**
    - co-axial
    - radio frequency
- **Digitisers**
- **Filters**
    - band pass
    - high pass
    - low pass
    - microwave
    - octave
- **Microwave Components**
    - attenuators
    - attenuators, variable
    - bends
    - cavities
    - couplings
    - crystal holders
    - directional couplers
    - duplexers
    - filters
    - flanges
    - horns
    - hybrid tees
    - isolators
    - matched loads, high power
    - matched loads, low power
    - mixers
    - short circuits
    - standing wave detectors
    - switches
- **Plugs and Sockets**
    - co-axial
- **Switches**
    - co-axial
- **Transducers**
- **Valves**
    - klystrons

PALMER, G. A. STANLEY, LTD., Maxwell House, Arundel Street, London W.C.2. *Tel.*: Temple Bar 3721.

Products

- **Accumulators, Hermetically Sealed**
- **Resistors, Fixed**
    - carbon, high stability
    - carbon, sub-miniature
    - wire wound, precision

TELCON METALS LTD., Manor Royal, Crawley, Sussex. *Tel.*: Crawley 1560.

Products

- **Alloys**
    - glass sealing
    - magnetic
    - resistance
- **Beryllium copper products**
- **Bimetals**
- **Cans**
    - screening
- **Cores**
    - C-type
    - E-type
    - magnetic powder
    - strip wound
    - toroidal
- **Laminations**
    - non-ferrous metals
    - ferrous metals
- **Powders, Magnetic**
- **Shields, Magnetic**
- **Tapes**
    - resistance
- **Wire**
    - copper-manganese alloy
    - copper-nickel alloy
    - nickel
    - nickel-chromium
    - stainless steel

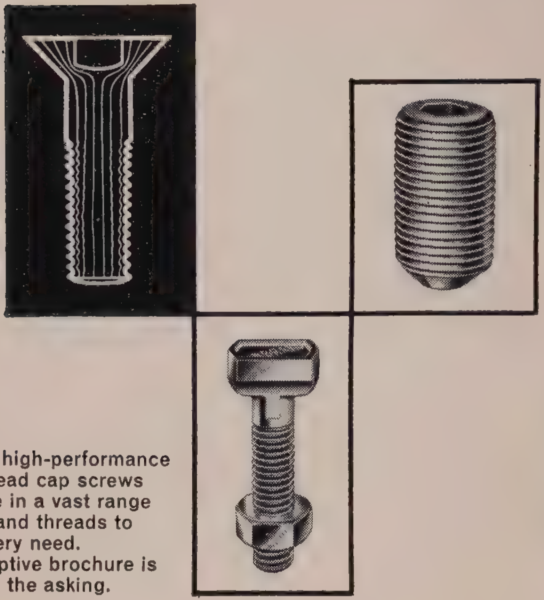
CORRECTIONS

The following name and address of an associated company of G. A. Stanley Palmer Ltd. should be added to the address section: DEAC (GT. BRITAIN) LTD., Altona Way, Buckingham Avenue, Trading Estate, Slough, Bucks.

Hayes Radio Ltd., in the address and classified sections should read Haynes Radio Ltd.

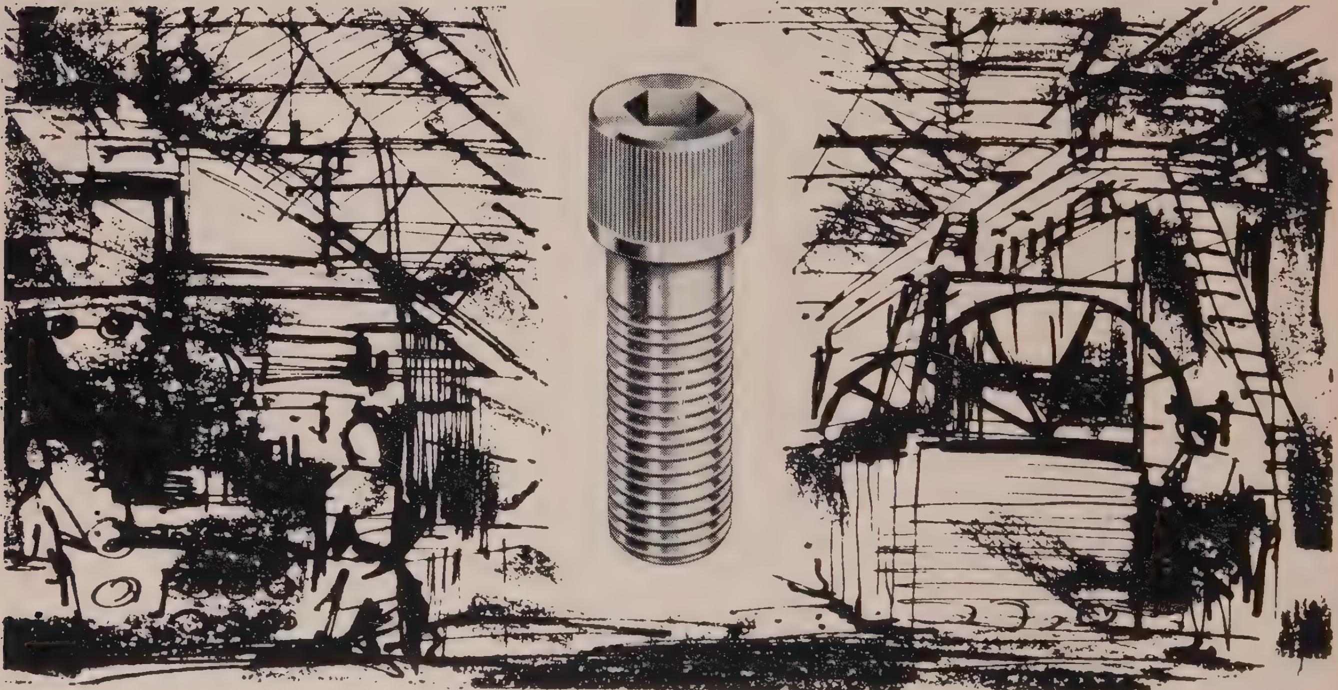
Westhouse Brake and Signal Co. Ltd., in the address section should read Westinghouse Brake and Signal Co. Ltd.

Performance is measured by true dimensions



Unbrako high-performance socket head cap screws are made in a vast range of sizes and threads to cover every need.
A descriptive brochure is yours for the asking.

Research, craftsmanship and rigorous control combine to make Unbrako screws the world's safest, each produced with that unerring dimensional accuracy which ensures unfailing performance. Dimensional accuracy includes the dimension which can only be measured in retrospect. The dimension of in-built performance. Millions of Unbrako screws have been proving this for years.



UNBRAKO

UNBRAKO SOCKET SCREW CO LTD COVENTRY TEL: 89471

ALSO MAKERS OF: CAP SCREWS · BUTTON HEAD SOCKET SCREWS · COUNTERSUNK SCREWS · PRESSURE PLUGS · RING BOLTS SET SCREWS · SHOULDER SCREWS · SQUARE HEAD SET SCREWS · T BOLTS · T NUTS · SEL-LOK · STAINLESS STEEL AND COLLARS

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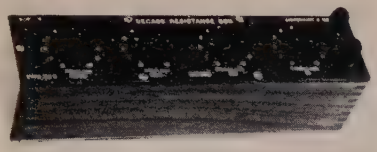
NEW COMPONENTS

Decade Resistance Box

The decade resistor box Type RD2, manufactured by Lionmount & Co. Ltd., is a switched unit covering the range 1 Ω to 10,000 Ω with four dials.



Decade resistance box.

It has been designed for use primarily in development laboratories and technical colleges where medium accuracy is required, and where low price, robustness and convenience are important considerations.

Of very modest cost compared with other units, it is felt that every electronic engineer carrying out experimental work will welcome this addition to his development tools, whereby the resistance required in a particular circuit can be determined in a matter of seconds. Also, its accuracy and construction is such that with a few other resistors, it can be easily used as the variable in a variety of bridge networks up to audio frequencies.

The resistors are non-inductively wire wound with a copper-nickel alloy, and have been temperature stabilized. The maximum current marking on each decade, 600, 200, 60 and 20 mA., indicates the maximum continuous current permitted, but this value may be exceeded by 50% for short periods.

The accuracy of adjustment is better than 0·2% at 20°C, except for the lowest decade for which it is 1%.

Well-tried conventional switches having a minimum contact resistance of less than 6 mΩ are used, and these will give an extremely long life providing that the decade box is used with non-reactive circuitry.

The instrument is of rigid construction, having a solid mahogany case with a $\frac{3}{16}$ in. thick stove enamelled front panel. The control knobs have been chosen for ease of manipulation and they traverse markings of clear large white figures. An internal aluminium liner is fitted which makes contact with the front panel, and this provides totally-enclosed screenings for the switches.

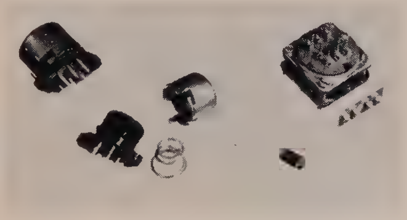
REC 101 *for further details.*

Adjustable Pot Cores

The Plessey Co. Ltd. announces the introduction of a range of "Ferramic T" adjustable pot-core assemblies from its Chemical and Metallurgical Division at Towcester.

The range, with diameters of 14, 18, 22 and 26 mm., is available in a series of standard effective permeability values of 63, 100, 160 and 220. The adjustment range is dependent on the gap size: a range of at least 14% of the mean inductance is achieved using a core with an effective permeability value of 100.

The smaller units are equipped with a six-pin base and bayonet fitting metal container, for use with a standard 0·1 in. grid printed board. The base also contains two fixing holes which are aligned with standard valve saddle fixing holes providing a convenient alternative chassis mounting.



Adjustable pot cores.

Metal plate clamping assemblies are available for the 26 mm. adjustable cores. Tapped bushes in the lower plate permit simple and rapid assembly. Either four-pin side or eight-pin top mounting boards are available, the latter being so spaced on a 0·1 in. grid that printed board mounting may be utilized. All the associated adjustment systems are contained within the height of the pot cores.

Close control of the manufacturing processes and the use of hyperpurity raw materials have resulted in a range of high-grade ferrites covering a frequency spectrum 1 kc/s to 2 Mc/s. The material characteristics include high initial permeability, very low losses and a close tolerance of temperature coefficient.

REC 102 *for further details.*

Power Transistors for V.H.F.

Motorola Semiconductor Products have now available, through Walmore Electronics Ltd., a series of four mesa power transistors for v.h.f. applications up to 250 Mc/s. The dissipation is 3 W. Typical performance is 0·5 W output at 160 Mc/s with 8 dB gain, and the type numbers are 2N1561, 2N1562, 2N1692, 2N1693.

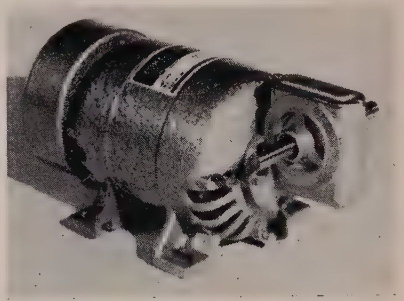
REC 103 *for further details.*

Fractional Horse-power Motors

Recently introduced by Comtex Ltd. is the first of a new range of fractional horse-power motors of advanced design giving a wide range of torque and output speeds. These are manufactured to Class "E" B.S. 2757 (which allows a temperature-rise of 65° above ambient), and are known as the GL8 (motor only), GL9 (motor with single reduction gearbox), and GL10 (motor with double-reduction gearbox). They are available for single- and three-phase supplies and for various voltages thus:

1/30 h.p. at 1,400 r.p.m. (nominal) 50 or 60 c/s, single-phase 100/110 V, 200/220 V, 230/250 V, and three-phase 400/440 V.

All motors, both induction and commutator type, are supplied as standard for reversing, and at no extra cost, a new design of capacitor can be fitted to the rear end of these motors to make compact, self-contained units—or alternatively the capacitor can be separately mounted in the usual way. They are easily mounted by foot or flange, and are suitable for running in any position, base holes being elongated for final adjustments. The gearboxes can be turned to bring the output shaft into a variety of positions to suit the job on hand, and practically any final output speed can be supplied.



"*Comtex*" 1/30 *h.p. motor with single-reduction gearbox, showing the built-in capacitor.*

All the shafts are ground to a fine limit, and ball journals or plain bearings can be fitted in all frames without dimensional alterations. Unless otherwise specified, all geared units have a ball thrust-journal at the gearbox end. All the bearings are prelubricated, giving long, trouble-free life, and the grease used in the gearboxes has been chosen to give a low-viscosity coefficient.

"Encapsulated" windings will be available in addition to the normal Class "E" B.S. 2757, rendering them impervious to attack by moisture, oil, and most chemicals. Thus, an open drip-proof motor "encapsulated" in this way can often be used in place of a totally-enclosed frame, obviating the need for a larger unit.

Each unit is tested electrically and mechanically at every stage of manufacture and carries a 12-month guarantee. All the rotating parts are statically and dynamically balanced electronically, using the most up-to-date machine specially developed for this purpose. Basically, this machine gives an output signal, amplifies and feeds it to a meter indicating the amount of imbalance, the angular position of this imbalance being indicated by a stroboscopic lamp.

REC 104 *for further details.*

Dual Zone Temperature Controller

A new mercury-in-steel, on-off temperature controller (Type 1039), which has independent circuits allowing control at any two points through one instrument, has been produced by the British Rototherm Co. Ltd.

Each of the two controller circuits consists of alloy steel Bourdon tubes, capillaries and temperature sensitive bulbs, operating mercury switches rated up to 30 A at 230/250 a.c. The differential is fixed but varies according to switching capacity.

Indicator lamps and bottom entry electrical conduit are standard. Temperature ranges are available between minus 20°F and plus 1,000°F (minimum coverage 100°F) and the equivalent °C.

The case is aluminium alloy and the standard capillaries 10 ft. copper sheathed with mild steel bulbs screwed $\frac{1}{2}$ in. B.S.P.

REC 105 *for further details.*

RCA Components

A number of new RCA components are now available from RCA (Great Britain) Ltd. These are as follows:

Improved power triode. The RCA-5762-A is a new forced-air-cooled power triode for v.h.f. service television and c.w. application, unilaterally interchangeable with the 5762/6C24, having improved qualities for f.m. applications and increased ratings. It has a maximum plate dissipation of 4 kW and is rated for operation up to 220 Mc/s. The 5762-A retains the radiator for low blower requirements; the thoriated tungsten filament for economical power consumption; and complete shielding between filament leads and plate, low grid-to-plate capacitance, and high perveance for use in grounded-grid circuits to provide stable triode performance at high frequencies. In broadband television service at 216 Mc/s, it can deliver a synchronizing-level power output of 6·35 kW when supplied by a driving power of 0·98 kW.

REC 106 *for further details.*

Premium germanium transistor. Designed for computer switching applications, this is the 3907/2N404 premium, certified reliability version of the industry preferred 2N404. It provides, for what is said to be the first time, completely documented reliability and lot-acceptance data in each shipment.

REC 107 *for further details.*

150-W silicon power transistors. These are the Types 2N2015 and 2N2016 silicon *n-p-n* power transistors providing extremely low saturation resistance and power dissipation up to 150 W, and designed for operation at case temperatures ranging from −65°C to +200°C. They are particularly useful in power switching circuits such as those employed in d.c.-to-d.c. converters, inverters, choppers, and relay control equipment; as well as oscillator, regulator, and pulse-amplifier circuits together with class A or class B push-pull amplifiers for a.f. and servo applications. These new transistors, formerly known by their developmental numbers TA-1884 and TA-1884-a respectively, now offer circuit designers a replacement for germanium transistors of comparable power ratings.

REC 108 *for further details.*

Multiplier phototube. The RCA-8054 is a 3 in. diameter, 10-stage head-on type multiplier phototube specifically designed for scintillation counting. Some of its features are: improved cathode sensitivity to blue light, low dark current, relative insensitivity to external magnetic fields and non-critical adjustment of interstage voltages. Rating and performance characteristics are measured with a light source having a spectral distribution closely matching that of typical scintillators. Design features include a semi-transparent photocathode having a minimum diameter of 2·59 in., a first dynode having a large area; a flat window to facilitate the mounting of flat phosphor crystals, and 10-dynode (secondary emitter) stages. The 8054 is the commercial designation for the developmental Type C-70030.

REC 109 *for further details.*

Silicon rectifier. JAN-1N547 is a military version of the Type 1N547 diffused-junction silicon rectifier and meets the requirements of military specification MIL-E-1/1083A. In addition to the JAN-1N547 silicon rectifier, the JAN-1N538 and JAN-1N540 are also available.

REC 110 *for further details.*

12-A silicon rectifiers. Fourteen new silicon rectifiers have been introduced to replace all corresponding prototypes and are designed to meet the stringent environmental and mechanical requirements of critical power supply applications. The type numbers are 1N1199-A, 1N1200-A, 1N1202-A, 1N1203-A, 1N1204-A, 1N1205-A, and 1N1206-A. Reverse polarity versions of these devices are available.

REC 111 *for further details.*

Novar tubes. These are the Types 6AY3, 17AY3 and 7868 halfwave vacuum rectifier tubes, designed for use as damper diodes in the horizontal deflection circuits of television receivers.

REC 112 *for further details.*

Sistaclips

Jermyn Industries has now extended its range of transistor clips to include the JEDEC TO5 and the JEDEC TO18. The range is as follows:

Sistaclip TO1-56-CP. Holds diameters from 0·189 in. to 0·250 in. including the OC44 to the OC201, etc.

REC 113 *for further details.*

Sistaclip TO1-256-CP. Half length version of the TO1-56-CP. Particularly suitable for the Ferranti diode ZS10A.

REC 114 *for further details.*

Sistaclip TO5-26-CP. Holds diameters from 0·305 in. to 0·358 in. including the Mullard OC170 and the JEDEC TO5.

REC 115 *for further details.*

Sistaclip TO5-36L-CP. Similar to the TO5-26-CP but fitted with an anti-rotation lug.

REC 116 *for further details.*

Sistaclip TO18-256-CP. Holds diameters from 0·150 in. to 0·200 in. Designed to hold the JEDEC TO18 transistors.

REC 117 *for further details.*

Sistaclip TO18-56-CP. Double-length version of TO18-256-CP. Suitable for two tunnel diodes in the JEDEC TO18 case.

REC 118 *for further details.*

Sistaclip TO5-38L-CP. Similar to TO5-26-CP but fitted with an anti-rotation lug and made of 0·008 in. beryllium-copper.

REC 119 *for further details.*

Sub-miniature valve clip. Holds valves nominally 0·4 in. in diameter.

REC 120 *for further details.*

Cannon Plugs

The following are selections from the 1961 range of Cannon plugs manufactured by Cannon Electric (Great Britain) Ltd. Details of each type are:

D-subminiatures with Crimp Snap-in Contacts

1. Mates with original D-subminiatures
2. Insulators—monobloc construction for crimp snap-in contacts
3. Contact—designed to MS 3190
4. Cadmium plate with gold iridite finish
5. Five shell sizes
6. Insert arrangements with 9, 15, 25, 37, 50 contacts
7. Accessories available—junction shells, potting cups, etc.

REC 121 *for further details.*

Environmental D-subminiature

1. Subminiature rack and panel
2. High altitude sealed applications
3. Has internal peripheral seal that allows plug to be partially disengaged (⅛ in.) and still maintain seal
4. Insulator is monobloc construction
5. Has crimp snap-in contacts to MS 3190
6. Built-in potting cups
7. Insert arrangements with 9, 15, 25, 26, 37, 50 contacts
8. Six shell sizes

REC 122 *for further details.*

D-subminiatures with Snap-in Coaxial Inserts in Combination with Contacts

1. Mates with all D-subminiatures
2. Monobloc insulators
3. Crimp snap-in coaxial contacts
4. Available with snap-in high voltage contacts
5. Combination layouts up to 4 coaxial inserts with up to 25 contacts.

REC 123 *for further details.*

DPAM (DPA with Snap-in Contacts)

1. Mates with standard DPA plugs
2. Monobloc insulators for crimp snap-in contacts
3. Contacts—designed to MS 3190
4. Available with snap-in coaxial inserts

REC 124 *for further details.*

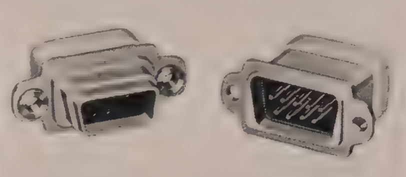
DPXM/DPDM (DPX and DPD Plugs with Snap-in Contacts)

1. Mates with standard DPX and DPD plugs
2. Monobloc insulators to accept crimp snap-in contacts
3. Contacts—designed to MS 3190
4. Available with snap-in coaxial inserts

REC 125 *for further details.*

Dual Rack/Panel Plug-DPX2-( )-33A and DPX 2-( )-34A (ARINC)

1. Meets ARINC standards for air transport equipment cases and racking
2. 99 alternate positions
3. Up to 114, #20 contacts plus other insert arrangements containing coaxial and high-voltage contact combinations
4. Overall dimensions—only 2 in. × 3⅛ in.



Environmental D-subminiature.

5. Certain insert arrangements are now available with crimp snap-in contacts to MS 3190

REC 126 *for further details.*

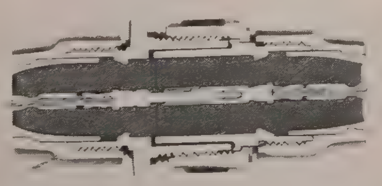
TM (Miniature Twinax Plugs)

1. Miniature Twinax plugs used with RG-108A/U shielded twin-wire cable
2. Can be used as a two-wire plug
3. Diallyl phthalate insulator assemblies can be reversed in plug and receptacle for polarization
4. Improved clamping method for braid insures grounding under vibration
5. Cable and insert are retained to prevent rotation
6. Operation voltage—250 V a.c. at 7½ A

REC 127 *for further details.*

RX (MS-R Type) Plugs with Crimp Snap-in Contacts

1. Exceeds applicable requirements of MIL-C-5015
2. Continuous sealing feature affords superior high altitude, air leakage and moisture resistance performance
3. Has crimp snap-in removable contacts conforming to MS 3190



RX(MS-R Type) plug.

4. Incorporates new two-shore resilient insulators moulded into one homogeneous unit for reliable, continuous seal and contact retention
5. Now "sleeved" socket contact (Probe-proof)

REC 128 *for further details.*

KPT/KSP Miniature Plug

1. Miniature plug for aircraft, missile and general purpose requirements
2. Designed to MIL-C-26482; 6 service types
3. Has standard solder cup contacts and available with crimp, snap-in contacts (Type MIL-C-26636)
4. Crimp version exceeds specification—meets altitude-immersion, air leakage and moisture resistance tests
5. Interchangeable and mates with all plugs (bayonet lock type) to MIL-C-26482
6. Removable contact design incorporates new two-shore resilient insulators moulded homogeneously into one unit for reliable seal and contact retention

REC 129 *for further details.*

KM (Mark II) Miniature Circular Plug

1. Mates with standard KM Plugs
2. Has threaded endbells to more easily compress the sealing grommet
3. Grommet and insulator are bonded together to insure a more positive seal
4. Crimp snap-in contacts to MS 3190

REC 130 *for further details.*

Cellulose Acetate Electrical Tape

Paynes Jiffytape Ltd. are marketing a low cost cellulose acetate electrical tape which has been produced to meet specific requirements in the electronic and electrical engineering industries. It is claimed that the tape can withstand a working temperature of 130°C without any loss of its insulation properties and is suitable for many of the drying-out procedures used during coil manufacture.

It is based on a pure transparent cellulose acetate. The key-coated film is coated with an electrical grade adhesive which has been processed to ensure that the tape maintains a high resistance to corrosive substances.

A particular advantage is the easy unwind properties which makes dispensing and stripping a simple matter and also reduce the risk of breakage—a common fault with many other types of acetate film.

This tape has been used with success in the manufacture of coils constructed of extremely fine wires where absence from corrosive substances, thinness, moisture and high insulation resistance are of the utmost importance.

Though polyester silicone and polyester thermosetting tapes fulfil many of the functions of cellulose acetate electrical tape, their use is often limited because of the high cost of raw materials. For this reason, it is anticipated that tapes made from cellulose acetate will be welcomed by many manufacturers.

REC 131 *for further details.*

R.F. and Switching Transistors

The GET88/89 range of r.f. and switching transistors, mounted in the JEDEC TO-5 can, is now available from the G.E.C. Semiconductor Division. This range is produced on a completely new, mechanised, line and as a result prices are very low. The GET88/89 range is already cheaper than the GET87 series from which it is developed and which has been in production for several years.

Brief specifications

RADIO RECEIVER TRANSISTORS	
GET883	i.f. amplifier
GET884	Mixer

SWITCHING TRANSISTORS

	$V_{cb\,(max)}$ (V)	Typical h_{fe}	Min. f_α (Mc/s)
GET881	−15	45	3·5
GET882	−15	65	7·5
GET883	−15	90	15
GET891	−20	45	3·5
GET892	−20	65	7·5

RF AMPLIFIER TRANSISTORS

	$V_{cb\,(max)}$ (V)	h_{fe} range	Min. f_α (Mc/s)
*GET880	−15	50—100	7·5
GET887	−15	50—100	3·5
GET888	−15	100—200	3·5
GET889	−15	50—100	7·5
GET890	−15	100—200	7·5

* Low noise transistor; maximum noise factor (1 kc/s): 5 dB.

The GET88/89 range of germanium *p-n-p* alloy transistors is divided into three groups—for use in switching circuits, radio frequency amplifier and oscillator applications, and radio receivers. Its main advantages are as follows:

By virtue of their low price, these transistors can economically be used in audio and i.f. circuits as well as r.f.

Device outlines are internationally standard and conform to K1007, V.A.S.C.A. and I.E.C. specifications.

Electrical interchangeability with well-known GET87 series. 20 V ratings are available.

Controlled gain range—2:1 spread on r.f. types simplifies circuit design.

All types are of similar construction, being enclosed in a standard JEDEC TO-5 case, and have a common power dissipation rating of 100 mW at 25°C derating to zero at 85°C.

An advance data sheet is available.

REC 132 *for further details.*

Glass-fibre Insulated Flexible Cable

British Insulated Callender's Cables Ltd. announce the availability of a flexible glass-fibre insulated cable for use as a light fitting connection. This is an addition to their existing range of miscellaneous cables.

The new cable, which is suitable for 250 V operation, is specially designed to function at the high temperatures likely to be encountered in contemporary lighting fixtures used for illumination in modern office blocks, large stores and in enclosed show cases.

In its natural state, the glass-fibre used for the insulation—treated with a suitable form of varnish binder and filler—will not burn or carry flame. Should the cable be subjected to an external source of heat, with temperatures of up to 180°C, the insulation and conductor remain intact, permitting a continued flow of electricity.

REC 133 *for further details.*

Frame-grid Valve for Television Tuners

A new frame-grid triode introduced by Mullard Ltd. enables the design of simpler less expensive r.f. amplifier circuits in television tuners.

The new valve, Type PC97, can be used instead of the double-triode commonly employed in television r.f. amplifiers. This is made possible by its exceptionally low anode-to-grid capacity of 0·5 pF—achieved by the introduction of earthed shielding plates between the grid backbones and the anode.

The noise factor of an r.f. stage using the PC97 is of the same order as that of a double-triode cascode stage. The gain will be somewhat lower but in television tuners high gain is not always an advantage, and it if often more satisfactory to increase the i.f. sensitivity of the receiver.

Another feature of the PC97 is the special arrangement of the cathode leads and the provision of two cathode pins, which reduces the cathode lead inductance and gives good input damping.

The valve has a mutual conductance of 13 mA/V at an anode current of 11 mA. Changing the bias from −1 V to −5 V reduces the mutual conductance 100:1.

Maximum physical dimensions of the valve, which has a B7G base, are 47·5 mm seated height × 19 mm diam., and the heater is rated at 4·5 V, 300 mA.

REC 134 *for further details.*

Long-life Thyratrons

The English Electric Valve Co. Ltd. has introduced two new hydrogen thyratrons, CX1140 and FX297 for applications in radar transmitters, linear accelerators and other pulse-switching equipments. The CX1140 is designed for use as a pulse modulator switch and the FX297 as an inverse diode. Both valves have a new design of hydrogen reservoir which is electrically in series with the heater and which enables the correct hydrogen pressure to be maintained. With this system an auxiliary controlled reservoir supply is therefore not required, and a considerable increase in the operating life of the thyratrons is achieved. The other characteristics are in no way inferior to the earlier range of non-reservoir tubes.

The CX1140 is a tetrode, with low pulse-to-pulse jitter and low anode delay time drift characteristics and by virtue of its good recovery time is suitable for use at high pulse-repetition rates. The precise triggering associated with this tetrode enables it to be used in parallel for switching high powers. It may also be used for switching long pulses provided the mean current is not exceeded. The CX1140 is a direct replacement for the well-known CX1119 but has an improved heating factor of 9×10^9 VA p.p.s. and a longer operating life introduced by the reservoir.

CX1140 and FX297 hydrogen thyratrons.

The FX297 has a long recovery time and is therefore suitable for use as a triggered inverse diode (backwash diode) in high-power long-pulse length modulators. Triggering may be achieved by the use of an insulated toroidal pulse transformer in the anode circuit of the pulse modulator switch tube. Since the FX297 has to hold-off an inverse voltage the necessary low gas pressure can only be maintained throughout life at the correct level by means of the hydrogen reservoir.

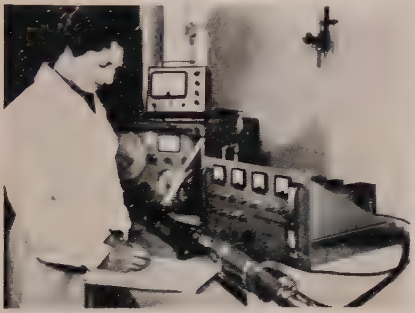
REC 135 *for further details.*

Quadrupole Amplifier

The English Electric Valve Co. Ltd., announces the introduction of a 400 Mc/s quadrupole amplifier ("Adler tube") for use in applications where a very low noise figure is a necessity. The tube is packaged with a focusing solenoid and may be supplied complete with an associated power supply unit if required. With the addition of the new tube the English Electric range of quadrupole amplifiers now comprises the N1036 for operation in the 200 Mc/s region, the N1037 600 Mc/s tube, and the N1044.

The N1044 is a transverse field device in which an electron beam interacts with an r.f. field transverse to the normal path of the beam.

Under large input signal conditions the tube is cut-off and this affords complete protection to any following stages. Circuit paralysis or recovery time is extremely short, following the application of an excessive input-signal overload.



A 400 Mc/s quadrupole amplifier on test in the laboratories of the English Electric Valve Co. Ltd., Chelmsford. The associated power unit is also shown.

A gain of 20 dB is available with a bandwidth, to 3 dB gain points, of 50 Mc/s. The noise figure is less than 2 dB over a bandwidth of at least 25 Mc/s and the tube has a saturation output power of 50 μW. The centre frequency of the N1044 is 408 Mc/s and the tube operates with a magnetic focusing field of 147 Gauss.

The power unit provides a d.c. current stabilized supply for the solenoid, d.c. supplies for the tube electrodes and the r.f. pump power. Metering facilities are provided on the front panel to enable the tube beam current, cathode current, structure current and the electrode voltages to be measured. Controls enabling the pump level and pump frequency to be adjusted over set limits are also brought out to the front panel.

The inclusion of the power supply unit means that by making suitable mains input power supply and signal connections the equipment may be permanently or temporarily included in new or existing designs as a low noise amplifier. Applications of quadrupole amplifiers include radar head amplifiers, input circuits for radio astronomy and tropospheric scatter communications systems and i.f. amplifiers for millimetre equipment.

REC 136 *for further details.*

Computer Tape Unit

The Type 4000 computer magnetic tape transport introduced by Decca Radar Ltd. can be employed with any digital computer, and is claimed to be the most advanced computer tape unit available in the world.

The Type 4000 follows the Type 3000 twin-tape unit which has been designed for operation with the new generation of high-speed computers now coming into service in the industrial, technical and scientific field.

Outstanding features of the new Decca equipment are complete absence of computer programme restrictions, quietness in operation, the provision of automatic loading and unloading routines, simplicity in design and operation, and the absence of maintenance adjustments. Wide margins of performance and continuous rating of components are characteristics of the design, ensuring reliability, serviceability and freedom from scheduled or unscheduled maintenance.

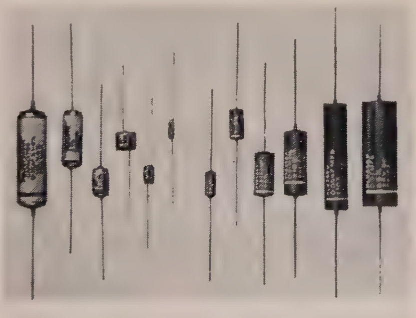
The tremendous advances made in the reliability of electronic computers over the last few years have set very high demands on the reliability of computer peripheral equipment, at the same time as the increasing requirements for higher performance. The demand for lower levels of maintenance becomes even more important as the number of peripheral units on computers increases. Decca claim that the intensive development and design work embodied in the Type 4000 will lead to higher utilization of basic computer time by reducing the time formerly lost in servicing, and in reconstituting a programme after a breakdown.

REC 137 *for further details.*

Polystyrene Capacitors

A new range of close-tolerance polystyrene capacitors is announced by the Capacitors and Resistors Division of The Plessey Co. Ltd. Previous limitations on the use of polystyrene as a dielectric have been largely overcome by new and improved manufacturing techniques which have vastly improved the capacitance/volume ratio.

Standard unprotected polystyrene capacitors are normally restricted to an upper temperature limit of about 70°C because of the risk of deformation as the softening temperature is approached. Encapsulation of the capacitors reduces the risk of deformation and the rated temperature limit can be raised to 85°C.



Range of polystyrene capacitors.

Capacitance range in the new series is 10 pF to 0·22 μF. Higher values up to 0·5 μF are available as non-encapsulated types and a range of aluminium-cased types covering the higher capacitance values is also being marketed.

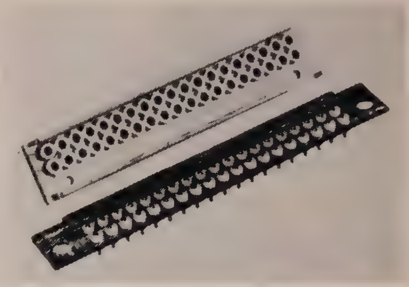
Working voltages for encapsulated and unprotected types are 125, 350, 500, 750, 1,000 V. Encapsulated types are also available for operation at 2,000 V.

High insulation resistance and low power factor are important characteristics of polystyrene capacitors and typical values for units in the new Plessey range are 10^6 MΩ and 0·005 respectively.

REC 138 *for further details.*

Rack Panel Connector/Components

Components permitting "do-it-yourself" design and assembly of multi-point rack and panel connectors, eliminating the need for special tooling and production of multi-connector assemblies, are now available from the Sealectro Corporation. These components are said to be ideally suited for limited runs and production of equipment requiring running changes.



Sealectro rack and panel connector system.

The new components are probes and jacks featuring floating contacts which allow for normal misalignment and rocking motions in connect/disconnect operations. The equipment manufacturer punches his chassis and rack to accept the "Press-Fit" probes and jacks. These may be placed in the most advantageous positions for associated circuitry, instead of a single connection point, as is necessary with the usual multi-point connector.

The PR-400 probe and SKT-400 jack are the two components necessary to make up the complete rack and panel connection. Both provide a solder cup for termination of associated circuitry. Both are the usual "Press-Fit" design featuring a p.t.f.e. body with a through-chassis diameter of 0·148 in., requiring a 0·136 in. hole in the mounting panel. The combination of these components is good for many thousands of insertions with no appreciable increase in contact resistance. Preparation of the chassis and rack units may be done with any standard punch, or two-step drill, conforming to recommended dimensions. The units are available in all standard colour p.t.f.e. bodies for coding purposes.

REC 139 *for further details.*

A magnet assembly is adjusted during the manufacture of a Type 4037 microphone at the North Woolwich factory of Standard Telephones & Cables Ltd. The 4037 is an omnidirectional moving-coil microphone of unobtrusive appearance and is widely used for television interviewing and general studio work. It has a response range of 30 to 15,000 c/s.

REC 140 *for further details.*

High-voltage Medium-power Silicon Diodes

Two new ranges of high-voltage medium-power silicon diodes are available from Westinghouse Brake and Signal Co. Ltd. The SxBR8 is rated at 18 A and may be used at case temperatures up to 140°C, whilst the SxBR25 is rated at 30 A and may be used at similar case temperatures. Both ranges are freely available in voltage ratings of 100 to 1,500 V peak, with ten intermediate voltages.

Two examples of the h.v. m.p. silicon diodes.

The diodes are hermetically sealed using glass/metal seals and the latest press seal techniques. Mounting is by means of a stud base which also serves as the anode connection. The cathode connection is made by means of an insulated flexible lead through the glass/metal seal.

REC 141 *for further details.*

MANUFACTURER'S ARE INVITED TO SEND DETAILS OF ANY NEW COMPONENTS FOR POSSIBLE INCLUSION IN THIS SECTION

NEW AMERICAN PRODUCTS

These products are available only from America or from European agencies and there is likely to be some delay in providing readers with further information.

Waugh Engineering Company

D.C. Output Turbine Flowmeter: The features of the turbine flowmeter are: output of −24 MV d.c. to +24 MV d.c. biased around 6 V d.c.; output impedance of 350 Ω; roll-off circuit to provide inverse gain to frequency characteristics for noise rejection; wide temperature range through the use of silicon transistors; low power requirements of 25 mA maximum; 12 G r.m.s. vibration; 100 G shock; accuracy of ±¼%.

REC 142 *for further details.*

Sel-Rex Corporation

Gold Electroplate for Electronic Applications: An extra high purity gold electroplating process, Temperex HD, produces deposits of 99·99½% purity, affording a uniformity of metallurgical characteristics. Temperex HD electroplate is also reported to exceed the requirements of such standard electronic product-acceptance tests as exposure to 550°C/10 min.; 300°C/96 h in air.

REC 143 *for further details.*

Leach Corporation

Half-size Crystal: The M-250 revolutionary half-sized crystal, only 0·35 oz. in weight and 0·128 in.^{3} in volume, can relay, and has a configuration that insures better than 50% space economy in a printed circuit and, therefore, offers substantial reduction in the size of electronic packaging.

REC 144 *for further details.*

Semi-Elements Incorporated

Lead Telluride: One of the upcoming thermal electric materials both in single crystal and polycrystalline form is available both in *n*- and *p*-type material.

REC 145 *for further details.*

Barium Fluoride: Doped with various rare earths and transition elements single crystals ¾ in. in diam. by 1 in., barium fluoride has been added to the growing list of available baser materials.

REC 146 *for further details.*

Raytheon Company

Raysistors: Compact and noiseless, the new line of six Raysistor relays and potentiometers designed for close, back-to-back-mounted circuit boards has recently been announced.

REC 147 *for further details.*

Decade Counter: Requiring less space than precious models, the CK7978 decade counter has a cold-cathode, gas-filled tube, which operates up to 5 kc, featuring a visual neon read-out or electrical read-out available from each of the ten cathodes. Total anode current ranges from 0·30 mA to 0·60 mA.

REC 148 *for further details.*

Raysistor Relay and Potentiometer: Models CK-1111 and CK-1112 are designed for noise-free control of a.c. or d.c. signals over a wide range. The two electro-optical components incorporate a light bulb and photocell assembled in a light-proof casing.

REC 149 *for further details.*

Miniature Tube for Television Receivers: The new 6HB6, a T6½ miniature pentode, incorporates a newly-engineered grid design which provides a more linear transfer characteristic and a transconductance of 25,000 μΩ. It fills the void for a high-sensitivity, high-output, vertical deflection tube.

REC 150 *for further details.*

Switching Transistors: The high-voltage, high-current audio switching transistors have been designed for military and industrial service as low-frequency, intermediate-power switches. The new germanium *p-n-p* units have particular applications as relay controls, solenoid drivers, choppers and d.c. to d.c. converters, and are designed to be used in regulator, oscillator, and pulse-amplifier circuits and servo applications.

REC 151 *for further details.*

Diffused-junction Silicon Rectifiers: All welded and hermetically-sealed in a metal and glass case, the high-temperature medium-current rectifiers are designed for use where high inverse voltages, high forward conductance, very low leakage current and extremely high rectification efficiency are required. Operating ambient temperature range is −65 to +175°C.

REC 152 *for further details.*

Weldpower Model JA: Designed principally for manufacturers of semiconductors, electronic equipment and modules, the Weldpower head features an extremely fast forging force and adjustable steel ball bushings.

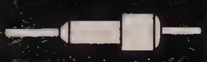
REC 153 *for further details.*

High-voltage Raysistor Isolator: The Raysistor isolator controls circuits at 25,000 V from ground level circuits. Two models of the device are the CK-1105 using 120 V for the control and the CK-1105 using 5 V for the control (light source).

REC 154 *for further details.*

TERMINAL BOARDS

LUGS



MOULDED INSULATORS

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HARWIN

Harwin *make* components—*specialise* in components. Lugs, moulded insulators, terminal boards and chassis furnishings. 'Off-the-shelf' or to special design.
The *quality* of every Harwin component is the product of experienced, precision manufacture and rigid inspection—meeting, and in many cases surpassing standard specifications. In addition, Harwin *service* and *specialisation* in fulfilling individual needs is something to be experienced—talk over *your* component problems with Harwin and be sure of the *best* and most *effective* answer.

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MANUFACTURERS' PUBLICATIONS

Gear Boxes

Leaflet No. 10 from Reliance Gear Co. Ltd., describes their modular servo gear boxes, designed and assembled to meet individual specifications. Simplified modular construction utilizes standard plates for mounting rotating components. The basic module is a gear box conforming to DEF 5000, wherein up to seven shafts are mounted in ball bearings, and it is corrosion resistant throughout. Ball bearings are to ABEC, friction tested to EL.1889; double shielded and case sealed against dust, in a dust free assembly shop. Gear ratios are up to 43,000,000:1, using precision gearing to Admiralty Class 1. Accommodation is available for up to six components, servo motor, potentiometers, synchros, etc. Ratios/components are interchangeable for bread-board and prototype work and shafts are extendable both sides at any intermediate gear pass. Torque limiting slip clutches are in all ratios, and an eddy-current drag damper is available.

REC 155 *for further details.*

Electronic Components News

The May, 1961 issue of *Electronic Components News* available from RCA (Great Britain) Ltd. contains details of recent additions to the Company's range of tubes and semiconductors, together with a section called "looking ahead" where the progress of the Electron Tube Division and Semiconductor Materials Division is described.

REC 156 *for further details.*

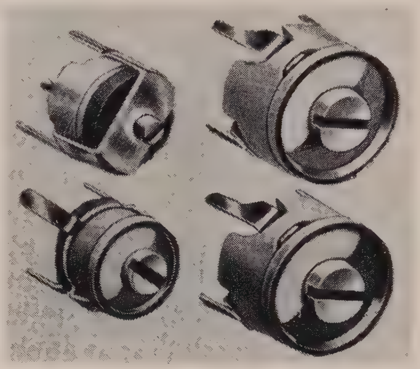
R.F. Shields

KnitMesh Ltd. have recently issued a 7-page catalogue and price list concerned with their electronic products including radio-frequency shields. The basic material of all the Company's products is KnitMesh, a knitted (not woven) mesh, which can be produced from almost any material obtainable in filament form. The electronic products of KnitMesh are in 5 categories: radio-frequency shielding; heat exchangers; air filtration; cushioning, and flexible all-metal leads. KnitMesh is made up into a full range of weatherstrips, gaskets and spindle glands, examples of which are illustrated. Besides the more standard all metal types, an unusual but efficient gasket is shown consisting of a KnitMesh cover over a rubber tube.

REC 157 *for further details.*

Trimmers

Two new ceramic sub-micro disc trimmers Types 7 S-TriKo 01 and 7 S-TriKo 02 are the subject of leaflets from Steatite Insulations Ltd. The new trimmers are substantially smaller than the already known 10 S-TriKo 06, and have been developed to meet the growing demand for further subminiaturization of components.



Types 01 (*top*) *and* 02 *compared with previous smallest types.*

Preliminary electrical data is as follows:

Rated voltage	160 V—			
Test voltage	740 V—			
Rotor material	P100	N033	N470	N750
Capacitance sweep C_{min}/C_{max} in pF	2/3,5	2,5/6	3,5/13	4/20
Permissible temperature range	−25 . . . +85°C			
Insulation resistance	$\geqslant 10^{10}\Omega$			

REC 158 *for further details.*

Darwins Group Ltd.

The Group's 1960 pictorial Finance Report is devoted to showing the sequence of production facilities of the Group. Commencing with raw materials the report shows the various stages of production and illustrates how each Company in the Group is connected to the others.

REC 159 *for further details.*

Collecon and Camlecon Connectors

Belling & Lee Ltd. has published an eight-page illustrated pamphlet which gives details about their Collecon and Camlecon range of connectors. These are based on an entirely new concept in plug-and-socket construction, whereby every pin is individually locked into its mating socket. This ensures complete and secure engagement of the contact and provides reliability and safety under all operating conditions.

REC 160 *for further details.*

Grundig TK14

A new revised instruction book for the Grundig TK 14 tape recorder has just been issued. The book is set out to explain to the user, in the simplest terms possible, not only how to operate the machine but also how to get the best from it.

REC 161 *for further details.*

Aircraft Electrical Equipment Brochure

The Plessey Co. Ltd., has made available an illustrated comprehensive 28-page publication which gives full details of the Group's capacity to engineer all electrical equipment as fitted to the latest types of civil and military aircraft.

REC 162 *for further details.*

Pye Argon Chromatograph

A comprehensive illustrated 28-page brochure issued by W. G. Pye & Co. Ltd., contains details of many techniques which have recently been developed in the field of chromatographic analysis.

REC 163 *for further details.*

Standard Relays

A new eight-page catalogue showing more than forty standard P & B relays is available from the Potter & Brumfield Division of American Machine & Foundry Co. Description, dimensions, technical specifications and prices are given for more than 450 variations of the basic relays.

REC 164 *for further details.*

Scanning Components

The Plessey Co. Ltd., has issued an illustrated brochure giving details of scanning components in current production for use in conjunction with 110° and 114° long and short neck television tubes. It also illustrates and describes deflection coil units, line and frame output transformers and line and frame blocking oscillator transformers, giving full details of the components' electrical characteristics and physical dimensions.

REC 165 *for further details.*

Marconi Instrumentation

The June technical information bulletin issued quarterly by Marconi Instruments Ltd., contains, among other things, details of the S-Band spectrum analyser, an oscilloscope pre-amplifier, and an article on the Standardization of Crystal Calibrators.

REC 166 *for further details.*

Relays

Standard Telephones & Cables Ltd., have issued a technical data sheet D 106 Ed. 1, concerning their relays for telephones. Types 4600, 4660 and 4630 are described together with their ratings and mounting information.

REC 167 *for further details.*

Terminology

Issued every two months by the Sealecto Corporation *Terminology* is intended to convey up-to-the-minute news on their "Press-fit" p.t.f.e. terminals, Sealectoboard cordless programming boards, ConheX r.f. coaxial connectors and contact engineering. Volume 1 introduces this product range and subsequent issues will give applications news and new developments.

REC 168 *for further details.*

Transistors

The April edition of *Semiconductor News* by A.E.I. Ltd., gives details of the Ediswan Mazda 1 W output transistor Type P.XC171 and driver transistor Type P.XB113 (package LF6).

REC 169 *for further details.*

PorTacutta Cut-off Machine

A coloured illustrated leaflet from Pee-Cee Engineering Supplies Ltd., describes their new lightweight PorTacutta cut-off machine that is 100% portable. Powered and serviced by Black & Decker the machine cuts time and costs for engineers, fabricators, welders, electricians on site and in the factory.

REC 170 *for further details.*

Ediswan Industrial Valves and Cathode-ray Tubes

A temporary catalogue pending the publication of a fully illustrated catalogue PD 16/2017 gives data of the following items: Accessories for vapour-cooled valves; Cathode-ray tubes; Forced air and water-cooled valves; Glow modulators; Half-wave high vacuum rectifiers; Half-wave mercury vapour rectifiers; Grid controlled rectifiers; Photo-cells; Photomultipliers; Power tetrodes and double tetrodes; Pulse amplifiers and modulators; Radiation-cooled power valves; Regulator valves; Saturated diodes; Special pentodes; Special quality valves; Telephone line protectors; Twin triodes; Vacuum delay switches; Vapour-cooled power valves; Xenon filled tetrodes; and Xenon rectifiers.

REC 171 *for further details.*

Wire Stripper

Described in a leaflet by Lyteze Products Ltd., is their new stripping tool for plastic-covered wires. The outstanding features are the ease and speed of its use by untrained operators without danger of damage to the conductors. Other special features are described in the leaflet.

REC 172 *for further details.*

Electroplating

Johnson Matthey & Co. Ltd. has issued data sheets which deal with the types of high-purity silver anodes available for vat and barrel plating under a wide range of conditions, and also give details of new rhodium plating methods and the well-established range of Johnson Matthey gold and silver salts.

REC 173 *for further details.*

Industrial Containers

A new series of Kabi bins, tanks and containers to meet every industrial need are described in a four-page leaflet produced by Kabi (Electrical & Plastics) Ltd.

REC 174 *for further details.*

Tube Products

Johnson Matthey & Co. Ltd. has issued a new series of data sheets describing its range of small-bore tubes and tube products, in terms of end uses, i.e., Bourdon tube, capillary tube, restrictor tube, instrument pointer tube, tube for applications in electronics and miscellaneous base-metal tubes.

REC 175 *for further details.*

Components

The May 1961 Catalogue Supplement produced by Belling & Lee Ltd., gives details of their new products which have been introduced since the general catalogue was issued. Crystal Oven Thermostats; Miniature Wander Plugs and Sockets; Ribbon Feeder Connectors and "Prestincert" Components are but a few of the items mentioned in the booklet.

REC 176 *for further details.*

Photoelectric Counters

A four-page leaflet issued by Tyer & Co. Ltd., describes their standard range of Perram counters now being manufactured. The types mentioned are the high-speed model Type HSC2/A—a six-digit counter with reset operating at 2,000 counts per minute, and the pre-selection counter Type HSC2/AA—equipped with relay and heavy duty contacts for batching control.

REC 177 *for further details.*

Precision Wirewound Resistors

The Ashburton Resistance Co. Ltd., have produced an 18-page catalogue dealing with the whole range of Arcol precision wirewound resistors. The catalogue is designed for clear and easy reference of their resistors and details include a dimensional drawing, a full specifications and a table giving the list prices throughout the range of ohmic values and tolerances grades.

REC 178 *for further details.*

Miniature Electronic Components

The new 1961 issue of the Ardente Miniature Component Catalogue includes full details of their range of miniature rotary switches now available with sealed spindles and with a spring return action. The range of standard transformers has been increased and a new miniature power transformer, the D 8000 series, introduced.

REC 179 *for further details.*

Contact Fingering

A leaflet recently published by the Sealectro Corporation, deals with a new range of contact fingering which is available in many variants of finger length, width and pitching. Typical uses include connections to the electrodes of co-axial and external anode type valves, wave-guide contacting, door bonding in screened rooms or cabinets and r.f. ovens.

REC 180 *for further details.*

ACTIVITIES in the Industry

Golf Raises Money for the E.I.B.A.

A record sum of £779 14*s.* 6*d.* was raised for the Electrical Industries Benevolent Association by this year's Midlands Area competitions of the Electrical Industries National Golf Championships, played over the Edgbaston (Birmingham) course. The total—more than £200 greater than that produced by last year's West Midlands competitions—was swelled by the results of a number of special efforts organized by the Area Chairman, Mr. V. J. Hadley (Managing Director of Hadley Telephone & Sound Systems Ltd.).

Automatic Treatment of Semiconductor Device Process Effluent

The recently completed plant constructed for the Texas Instrument Company at Manton Lane, Bedford has been designed to facilitate the most efficient production methods for the manufacture of semiconductor devices. Wherever possible, instrument control methods are employed and an example of one of these instrument methods may be illustrated by the application of pH control during the treatment of process effluent.

During semiconductor device processing considerable quantities of effluent are produced. This effluent is made of hydrofluoric, acetic, and nitric acids of varying composition, together with water-miscible solvents and large quantities of process water. The pH value of the effluent can vary between 0·5 and 5·0 and have a biochemical oxygen demand of approximately 2,000. Quantities of up to 74,000 gallons a day with peak flows of 7,000 gallons per hour are continuously and automatically treated before disposal into the Local Authorities drains.

Treatment of the effluent comprises a single stage chemical treatment followed by settling of solids and a final biological treatment. The effluent is first collected in two 3,000 gallon balancing tanks from which it is pumped under level control into a 1,500 gallon treatment tank where lime slurry is added under pH control. Precipitation of solids takes place most effectively at pH values between 7·5 and 8·0 and industrial pH measuring equipment, supplied and installed by W. G. Pye & Co. Ltd., Cambridge, coupled to a Taylor pneumatic controller adjust the rate of lime slurry addition to maintain these optimum conditions.

From the treatment tank the neutralized effluent is passed through a large settling tank where the suspended solids, mainly in the form of insoluble calcium fluoride, are removed. The final biological treatment, where the water-miscible solvents are reduced to an acceptable level, precedes a final pH check. As the clarified liquor leaves the effluent plant a continuous sample is taken and passed through a Pye flow-type electrode assembly and a continuous recording of the final effluent pH value is taken before the effluent is passed into the drains.

The treated effluent conforms to the local authorities requirements with fluorides below 30 p.p.m., metals in suspension and solution 20 p.p.m., suspended solids 20 p.p.m., B.O.D. 300 and a pH value between 6·0 and 9·0.

On Friday, 7th July, Dr. Bertram V. Bowden, M.A., Ph.D., M.I.E.E., Principal of the Manchester College of Science and Technology, received a specially bound volume of the Science Masters Handbook which has been produced by Advance Components Ltd. of Hainault, Essex.

The presentation took place at the Advance Stand during the 16th Annual Electronics, Instruments and Components Exhibition and Convention. Left to right are: Mr. D. J. Taylor, Chairman of the Council of the Institution of Electronics; Dr. Bowden; Mr. S. Jarvis, Advance Components Ltd.; Mr. P. Sidney, Sales Manager, Advance Components Ltd.; Mr. W. Birtwistle, General Secretary, I. of E.; and Mr. W. Mortin, Advance Components Ltd.

The Advance Science Masters Handbook has already been issued to many thousands of science masters both in Britain and the Commonwealth, and has been well received by the education authorities.

Marconi Television for Suez Canal

A Marconi-Siebe, Gorman underwater television camera is to be used by the Suez Canal authority to examine the underwater condition of the canal and the entrances to Port Said and Suez Harbours.

Damage is often caused to the cutting teeth of canal dredgers by submerged debris and the delay in repairing them is both time-wasting and costly.

The canal authority believe that much of this damage will be eliminated when the underwater television equipment is in use and a full set has been ordered from Marconi's Wireless Telegraph Co. Ltd.

New S.I.M.A. Officers

At the Annual General Meeting of the Scientific Instrument Manufacturers' Association of Great Britain, **Mr. A. W. Jones** [Fleming Radio (Developments) Ltd.] was installed as President for the year 1961-62 by **Mr. G. C. Ottway** (W. Ottway & Co. Ltd.), the retiring President.

The other Honorary Officers of the Association elected were: **Mr. R. E. Burnett** (Marconi Instruments Ltd.), Vice-President and President-Elect; **Mr. G. C.**

Ottway (W. Ottway & Co. Ltd.), Vice-President; **Major W. Logan** (Avo Ltd.), Hon. Secretary; and **Mr. G. S. Sturrock** (Kelvin & Hughes, Ltd.), Hon. Treasurer.

The newly-elected members to the Council were: **Mr. J. E. C. Bailey,** C.B.E. (Baird & Tatlock, London, Ltd.), a past President of the Association returned to Council; **Mr. A. G. Peacock** (Mervyn Instruments Ltd.); **Mr. L. B. Lambert** (Negretti & Zambra Ltd.); **Mr. J. E. T. Haile** (Rank Precision Industries Ltd.); **Mr. I. C. M. Worsfold** (W. H. Sanders Electronics Ltd.); **Mr. H. Wyn Griffith** (Shirley Developments Ltd.); and **Mr. A. Richardson** (Stanhope-Seta Ltd.).

The members of Council continuing in office are: **Mr. S. T. Pickering** (Chance Pilkington Optical Works); **Mr. G. M. Sisson,** O.B.E. (Grubb, Parsons & Co. Ltd.); **Mr. G. A. Whipple,** C.B.E. (Hilger & Watts Ltd.); **Mr. E. W. Semmons** (Nalder Bros. & Thompson Ltd.); **Mr. R. H. C. Foxwell** (The Wayne Kerr Laboratories Ltd.); and **Mr. A. W. Smith** (Wray Optical Works Ltd.).

New Factory for Aircraft-Marine Products

The Rt. Hon. John S. Maclay, M.P., C.M.G., Secretary of State for Scotland, will open the new Port Glasgow factory of Aircraft-Marine Products (Great Britain) Ltd. on Monday, 25th September next.

The new factory has an area of 60,000 sq. ft. enabling Aircraft-Marine Products to increase production of the AMP solderless terminals, connectors and associated products. This is in order to meet the increasing demand for its products in the electrical appliance, electronic, aircraft, shipbuilding, business machine and rail industries, also the power generating and distributing services. Increased production space will also mean that Aircraft-Marine Products can deal with the expanding world-wide demand and make an even greater contribution to the national economy both with direct and indirect exports.

The Company has been operating in Britain since 1955 and has provided a valuable stimulus to employment in Port Glasgow. When the new factory is completed it will be one of the most modern of its kind in Britain.

G.E.C. Radio Equipment for Canada

The General Electric Co. Ltd. is to supply *via* the Canadian General Electric Company the radio and multiplexing equipments for a broadband radio link between Moncton in New Brunswick and Gore in Nova Scotia, Canada. The link will consist of two terminal and two repeater stations and will carry two bothway s.h.f. radio channels operating in the 6,000 Mc/s frequency band. It will form part of the Canadian East Coast microwave network being developed by The New Brunswick Telephone Company and the Maritime Telegraph and Telephone Company.

The equipment will convey either a television circuit or 960 speech circuits on each radio channel and will link up with other G.E.C. equipments in the network operating in the 2,000 Mc/s band.

Magnavox Electronics Ltd.

Magnavox Electronics Ltd. have moved their head offices from 129 Mount Street, London, W.1. to Magnavox House, Alfred's Way, Barking, Essex. The new telephone number is Rippleway 5533.

Brazil Buys British Television

Radio Sociedade Gaucha, S.A. have just concluded a contract with Pye T.V.T. Ltd., Cambridge, for the equipping of a complete television station which Radio Gaucha plans to complete at the beginning of next year at Porto Alegre, Brazil.

The station is to include the necessary equipment for a three-studio television centre, with cameras, mixing systems and all ancillary equipment. A Pye 5-kW Band 3 transmitter will also be supplied and additional equipment has been purchased to fit out an Outside Broadcast Unit. Value of the contract is in the neighbourhood of £150,000.

The negotiations were conducted by the Managing Director of Radio Gaucha, Mr. Frederico A. Ballve, assisted by the Managing Director of Pye's Brazilian Agents, Electrobraz Comercia e Industria S.A., Mr. E. F. Eskenazi.

Marconi Television for Russia

Marconi underwater television cameras will be used for salvage operations by a fleet of seven Russian tugs, following an order for television equipment placed by the Finnish shipbuilding firm Valmet Oy.

Seven Marconi-Siebe, Gorman cameras and monitors are to be delivered to the Pansio Shipyard, Turku, for installation on board the diesel-driven salvage tugs now being built for V/O Sudoimport, Moscow.

Diving equipment, and underwater cutting and electric arc welding devices, are carried by the tugs. The Marconi-Siebe, Gorman television cameras will enable salvage experts to see work being carried out by divers using pressure air-driven tools.

Four Mullard Filmstrips

Four new filmstrips dealing with various aspects of electronic engineering have been announced by the Mullard Educational Service. Their titles are as follows:

The Manufacture of Junction Transistors.
Basic Transistor Circuits.
Amplification and Amplifiers (Parts I & II).
Amplification and Amplifiers (Parts III & IV).

The first two are intended for grammar school pupils or the more junior students at technical college, the others are designed especially for the student electronics engineer or technical trainee in the Services.

The Manufacture of Junction Transistors: This 38-frame, black and white filmstrip describes the manufacture of junction transistors step by step.

The first 14 frames cover the production, purification and precision slicing of the germanium raw material. Forming the *p-n-p* junction, assembly, final testing and quality control occupy the remaining frames.

Basic Transistor Circuits: This filmstrip is intended to familiarize the student with the outlines of basis transistor circuits and to provide him with sufficient background for further studies.

The strip comprises 29 coloured frames. It begins with diagrams showing fundamental transistor physics, and the following frames illustrate the three basic forms of transistor operation: common emitter, common collector and common base. Input and output characteristics for each method of working, and circuits showing the transistor used as an amplifier, oscillator and d.c. converter complete the strip.

Amplification and Amplifiers

Parts I & II: This strip comprises 25 coloured frames and is divided into two parts. The first part begins with a block diagram of an audio amplifier and goes on to illustrate in some detail the various classes of bias and methods of producing them. Part II continues by considering input and output circuits, types of load, parallel and push-pull operation, two-stage audio amplifiers, feedback, decoupling and, finally, the cathode-follower circuit.

Parts III & IV consider the requirements of an ideal amplifier for various types of service and the circuit features needed to meet these requirements. The various forms of distortion found in tuned, untuned and power amplifiers are covered in detail.

The strip consists of 31 coloured frames illustrating such subjects as inter-electrode capacity, Miller Effect, l.f. and h.f. compensation, impedance matching, types of distortion, equivalent circuits and other useful information.

All four strips are available now from Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens, London, S.W.1. Price 25s. (colour), 15s. (black and white) including comprehensive teaching notes.

S.T.C. Carrier Telephone System in Sardinia

The first installation of a new type of carrier telephone system has now been placed in service in Sardinia by the Italian Post Office.

The new system was designed by Standard Telephones & Cables Limited, London, and installed by Societa Italiana Reti Telephoniche Interurbane, S.A. Milan. It is particularly suitable for use in areas of relatively low telephone traffic density.

The system provides 300 telephone circuits on each pair of coaxial tubes in a cable of novel construction. The coaxial tubes are only 0·163 in. (4 mm) in diameter, and the cable is of similar construction to S.T.C. Type 163 cable now being supplied to the British Post Office, British Railways and telephone administrations overseas.

The frequency spectrum on each coaxial tube extends from 60 kc/s to 1,300 kc/s. This accommodates 300 speech channels each 300 to 3,400 c/s; the overall system has been designed to meet the C.C.I.T.T. noise specification for routes of up to 1,600 miles (2,500 km) in length.

Repeaters are inserted into the cable route every 12,000 ft. (3·66 km), at which spacing the cable loss to be compensated is of the order of 27 dB at the top frequency transmitted.

An automatic pilot control is incorporated in the system to provide continuous compensation for changes in the cable attenuation due to varying ground temperatures. The terminal equipment includes all the apparatus necessary to translate in frequency the 300 telephone circuits, which form the maximum complement of the system, and to position them in their appropriate places in the frequency band transmitted over the cable. The repeater equipment comprises terminal, main (power feeding) and dependent repeaters which are required to maintain the appropriate signal levels along the tubes of the coaxial cable.

Junction-type transistors are used throughout the repeater equipment, thus ensuring low power consumption and heat dissipation. The terminal and main repeaters are rack mounted.

The dependent repeater is designed to be accommodated in a buried housing which may contain one or two both-way repeaters. With the use of transistors, a compact unit with low current drain has been achieved suitable for completely unattended operation. Electrical connection of the repeater to the coaxial tubes is made by means of flexible plug-ended cords to facilitate repeater replacement when required.

Power to operate the dependent repeaters is fed over the coaxial tubes from the nearest main repeater or terminal station by passing a stabilized direct current through the repeaters in series.

A facility is provided to enable faults in dependent repeaters to be located from terminal and main stations using the interstice pairs within the cable.

New Creep of Steel Laboratory

The new Creep of Steel Laboratory which has been built during the past year, on the Electrical Research Association's site at Leatherhead, is concerned with the improvement in the efficiency of generation of electricity, primarily in steam-driven turbo-alternator sets, and is the latest stage of a long investigation that has developed continuously over nearly forty years. In that period steam raising conditions at power stations have risen from 600 lb./in.^{2} and 680°F (360°C) to 2,000 lb./in.^{2} and 1,050°F (565°C). The overall efficiency has consequently increased from under 20% to 34% in some cases.

This improvement has only been possible as the result of research on the high temperature properties of the steels used in the generating plant. The E.R.A. has been very actively associated with that research since 1930 when it set up a committee, upon which steel makers and turbine makers and users were represented, which sponsored the accurate investigation at the National Physical Laboratory of the high temperature behaviour of certain typical steels. As a result a creep-testing laboratory was built at the N.P.L. and equipped with some 75 high accuracy creep testing machines. A number of steels were examined here and in addition members of the committee submitted appropriate experimental results obtained in their own creep laboratories. It soon became evident that short-term testing was not sufficient and periods of test had to be extended to times of the order of 20,000 hours or more.

As knowledge of the properties of steels increased and steam conditions became more onerous, the number of special creep resisting alloys to be investigated also rose. The test programme thus expanded to such an extent that the laboratory at the N.P.L. could no longer cope with it even though it had been reinforced by a further 50 machines installed in 1957 at the E.R.A. Laboratories at Leatherhead.

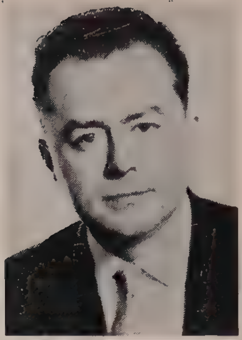
The organizations represented on the committee therefore decided to provide for an extended programme by means of a new laboratory at Leatherhead which would be devoted principally to long-time tests. This laboratory, completed at the end of 1960 with an area of 9,900 sq. ft., is equipped with 50 high sensitivity creep machines fitted with optical extensometers, 50 10-specimen rupture machines and 50 dual purpose machines for either dial gauge creep measurements or 3-specimen multi-rupture. One 15-ton creep machine is included for testing specimens from the full wall thickness of steam pipes. In addition to the creep and rupture machines, 11 rigs have been installed, designed to test tubes stressed by internal steam pressure while at high temperature. Four such rigs have been in operation for several years at Leatherhead and will be retained.

Sir Noel Ashbridge (centre) a director of Marconi's Wireless Telegraph Co. Ltd. is seen here chatting to Mr. W. Proctor Wilson, Head of Research, B.B.C. and Mr. F. C. McLean, Deputy Director of Engineering, B.B.C., at a cocktail party held by Marconi's and the English Electric Valve Co. Ltd. in Selby's Banqueting Rooms, London, to mark the joint presentation to the two companies of this year's engineering award of the National Academy of Television Arts and Sciences. The award, which was shared with the Radio Corporation of America, was in recognition of the independent development of the 4½ in. image orthicon camera and pick-up tube. One of the premier awards America can bestow in the field of electronics this is the first time it has been won outside the United States.

Over 150 guests from the electronics industry, B.B.C., I.T.V., programme contractors and the technical press were welcomed at the cocktail party by Mr. A. J. Young, Managing Director of the English Electric Valve Co. Ltd. and Mr. D. G. Smee, Manager of Marconi's Broadcasting Division, on behalf of the Managing Director, Mr. F. N. Sutherland, who was overseas.

Mr. G. A. Smith

PERSONALITIES



Mr. A. A. Farrell

Mr. G. A. Smith

Mr. Michael Clark, Director of the Electronic and Equipment Group of The Plessey Co. Ltd., announces the appointment of Mr. George A. Smith as General Manager of his Group.

Mr. Smith has been with the Company since 1957. His first responsibility was for the overseas selling of electronic equipment with Plessey International Ltd. He was later appointed General Manager of the Plessey Telecommunications Division, and became Commercial Executive of the Electronic and Equipment Group in 1960.

Mr. Smith's association with the world of electronics and telecommunications extends back to 1939. He spent the war years as a radar officer in 60 Group, serving with the R.A.F.V.R.

For ten years after leaving the Service, Mr. Smith worked with Pye Ltd., initially as a development engineer and later as the export manager of the Pye Telecommunications Division.

Mr. D. H. Maxwell

With the termination of the ATE/TMC transmission selling agreement, the Telephone Manufacturing Co. Ltd. is now establishing its own world-wide selling organization and Mr. D. H. Maxwell has been appointed Transmission Division Sales Manager.

Immediately prior to joining TMC, Mr. Maxwell, who is 41, was a Senior Sales Executive at the Head Office of Ericcson Telephones Ltd. During the war he was a Major in the Royal Signals, and afterwards joined the Transmission Laboratories of the General Electric Company as a Systems Engineer. Subsequently he joined Siemens as Transmission Sales Engineer, and then T. S. Skillman as Sales Executive.

In his new position Mr. Maxwell is responsible for co-ordinating and controlling all aspects of TMC's Transmission Sales activities. Under the reorganization **Mr. C. F. Ellis** will continue his present duties as Contracts Manager in the Division's sales department.

Mr. B. Feltbower

Mr. Bernard Feltbower, who recently joined The English Electric Company, has been appointed Chief Engineer of the Company's Control Gear Division at Kidsgrove, Stoke-on-Trent.

Mr. Feltbower, who is 49, was born in Vienna and holds the Engineering Diploma of the Technical University of Vienna, and the degree of B.Sc. (Eng.) at London University. He is a member of the Institution of Electrical Engineers. He will be responsible for all the technical administration and new projects of the Division at Kidsgrove which specializes in all aspects of electric motor control and the engineering of automatic control schemes for industrial processes.

After industrial experience in Austria before the last war as a project engineer, Mr. Feltbower joined Brookhirst Switchgear Ltd. in 1938 where he was responsible for the design and application of control gear. From 1947 until this year he worked for the Electro Dynamic Construction Co. Ltd., where he became General Manager and Chief Engineer of their Control Gear Division. During this time he was responsible for developing, amongst other things, automatic standby power supplies for conventional and nuclear power stations, etc.

Mr. Feltbower has published a number of articles on automatic control gear and has also read a paper before the Institution of Electrical Engineers on the design and application of contactors.

Mr. P. E. Groom

Mr. P. E. (Peg) Groom, Credit Manager of the Ekco Group of Companies, retired at the end of July after over 27 years' service, during which he has made many friends in the radio trade. He entered the radio industry in 1927 and joined E. K. Cole Ltd. in 1933. Mr. Groom will be succeeded by **Mr. W. A. MacArthur**, who joined E. K. Cole Ltd. in 1949 and graduated through the Sales Departments to the position of Assistant Credit Manager in 1958.

Mr. A. A. Farrell

Mr. A. A. Farrell has been appointed Director and General Manager of Plessey Ireland Ltd. and also a Director of Plessey Sales Ltd. Dublin.

Mr. Farrell was formerly General Manager of Plessey Ireland Ltd.

Mr. E. R. Pring

It is with deep regret that E. K. Cole Ltd. announce the death of Mr. E. R. Pring. Mr. Pring joined the Company as a director in the first year of its formation, 34 years ago, since when he has given highly valued service in that capacity, enjoying the esteem and affection of all those who came into contact with him. He retired from all business activities only last year.

The funeral took place at St. Mary's Church, Prittlewell on 12th July, E. K. Cole Ltd. being represented by Mr. E. K. Cole, his fellow directors and senior executives of the Company.

Mr. J. Large

British Insulated Callender's Cables Ltd. announce the appointment of Mr. J. Large, Winding Wires Divisional Manager, as General Manager, Winding Wires Division, with effect from 1st August, 1961. He will be responsible to Mr. E. Bowyer, Executive Director, for the administration of the Division and the operation of the Huyton Quarry, Melling and Bessbrook (Northern Ireland) factories. The acquisition by BICC of the share capital of Bessbrook Products Ltd. of Newry, County Down, was announced on 1st June, 1961.

The Home and Export Commercial activities of the Winding Wires Division will be operated by Mr. Large from Huyton Quarry, near Liverpool, in conformity with policies indicated respectively by **Mr. C. H. Broughton Pipkin,** Executive Director (Home) and **Mr. H. F. Akehurst,** Assistant Managing Director.

Dr. S. Jones

Dr. Sydney Jones has joined R. B. Pullin & Co. Ltd., as Technical Director. This appointment follows the Company's decision to ensure the enlargement of its activities throughout the whole field of electronics, electrics, electro mechanics, etc.

Dr. Jones was until recently Director of Research Applications at the Central Electricity Board, where he was responsible for the development of forward-looking research projects. In particular, he was responsible for the development of automatic process controls systems.

Between 1947-50 whilst he was at T.R.E., he became interested in the problem of automatic guidance of astronomical telescopes and contacted Professor Tustin of Birmingham University who was then a member of a committee set up to advise on the proposed new 100 in. Isaac Newton telescope for Greenwich Observatory at its new site in Hurstmonceaux. This led to his work with Professor Tustin at Birmingham on a scheme to develop a high precision servo-drive of the photographic plate on the Isaac Newton telescope. For this work he was awarded a Ph.D.

About this time he was also leading the R.R.E. team responsible for the application of infra-red to guidance of missiles and other devices. This work led directly to the Firestreak missile. Many of the novel techniques in this missile arose from his work and in conjunction with the Ministry of Supply, he holds many of the patents involved.

Dr. Jones was Superintendent of Defence Airborne Radar at Malvern from 1954-56, and headed the Armament Dept., R.A.F., 1956-59.

Mr. A. W. Jones, President of S.I.M.A.

Mr. A. W. Jones, recently installed as President of the Scientific Instrument Manufacturers' Association of Great Britain Ltd., was born in 1914.

In 1933 he joined Orr Radio, and later Invicta Radio as an inspector, becoming ultimately technical manager. On the Company's absorption by the Pye Group he joined Pye Ltd. in 1938, working on research and development in radar during the war.

In 1945 he founded Fleming Radio (Developments) Ltd., and the firm carried out an assortment of sub-contracts, while he developed an anti-jamming radar of his own. In 1947, he bought his first factory in Clerkenwell, and became a Government contractor. The Company subsequently expanded very rapidly.

Mr. A. W. Jones was Vice-President of S.I.M.A. for 1960-61 and has been a very active Council member for the past four years. His hard work as Chairman of the 1959 and 1960 Convention Committees had much to do with their inspired success. He was also Chairman of the Electronics, Telecommunications and Electrical Instruments Section to which 70 S.I.M.A. members belong, the Nucleonic Group and many of the Standing Committees of S.I.M.A.

Mr. R. S. Phillips

Mr. R. S. Phillips has joined the Instrumentation Division of Evershed and Vignoles Ltd. as Chief of Development dealing with electronic process control equipment. Mr. Phillips, who has been in the electronics industry for twenty years, was previously with Epsylon Industries Ltd. where he was engaged in the development of process controls in relation to textile manufacture.

Mr. Burkewood Welbourn

The death took place on 1st July at Caterham, Surrey, of Mr. Burkewood Welbourn at the age of 85. Mr. Welbourn was a former Director and Chief Engineer of the British Insulated Company. He retired in 1945 on the formation of BICC through the amalgamation of the BI Company and Callender's Cable and Construction Company.

Mr. Welbourn graduated from King's College, London, in 1896. After a period of service with the Electrochemical Company of St. Helens, he joined, in 1897, the British Insulated Wire Company of Prescot becoming Contracts Manager in 1902, in which capacity he travelled widely. In 1927 came his appointment as Chief Engineer, and in 1942 he was elected to the board of the BI Company.

In a lifetime spent in the electrical industry in which he had such a notable career, Mr. Welbourn had served as a member of the Council of the Institution of Electrical Engineers, was a vice-president of the Institution and past Chairman of the Manchester and Liverpool centres.

He is survived by his widow and all his five children.

Mr. R. W. Hall

It is with deep regret that Antiference Ltd. announce the death on Friday, 21st July, 1961, of Mr. R. W. Hall (Bill Hall), Chief Sales Executive of the Aerial Division. Mr. Hall, who was 47, had been very ill in hospital since early April.

Although with Antiference for only nine years he had been closely associated with the radio industry for more than 27 years of his working life. He leaves a widow and two children.

The funeral was held at Fulford Church, York on Thursday, 27th July.

Mr. C. O. Boyse

British Insulated Callender's Cables Ltd. announce that Mr. C. O. Boyse, B.Sc.(Eng.), M.I.C.E., M.I.E.E., Fel.A.I.E.E., on relinquishing his appointment as Managing Director of the Automatic Telephone & Electric Co. Ltd., was appointed an Executive Director of BICC as from 6th July, 1961. Mr. Boyse, who has been a member of the BICC Board since 1956, is now responsible to Mr. W. C. Handley, Assistant Managing Director of BICC, for the operation of certain Home Group Companies other than those primarily engaged in cable making.

Mr. P. Allaway

Mr. Percy Allaway was appointed Managing Director of E.M.I. Electronics Ltd. on 1st July, in succession to Clifford Metcalfe, C.B.E., who relinquished the post at his own request but remains a full-time director of Electric & Musical Industries Ltd.

Mr. Allaway joined the Gramophone Co. Ltd. in 1930, and was trained in the drawing offices and manufacturing departments of the vast HMV plant.

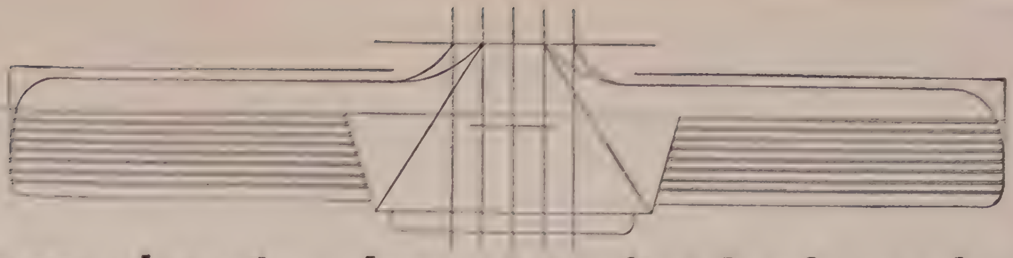
Mr. Allaway foresees the completely automatic factory of the future as being equipped with analogue computers for basic design research, digital computers to process all clerical data from receipt of order to management statistics, electronically-controlled machine tools, closed-circuit television for inspection, and driverless Robotugs for transporting materials and products through all stages of manufacture.

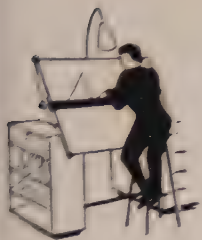
Mr. J. H. Maxwell

The retirement from his executive duties is announced of Mr. J. H. Maxwell, Director and General Manager of Messrs. W. T. Glover & Co. Ltd., of Trafford Park, Manchester 17—a member of the BICC Group—after 51 years' service with that Company.

The career of Mr. Maxwell, who was born in Manchester, is one of the success stories of the cable industry. He joined W. T. Glover & Co. Ltd. in 1910 as an office boy. In 1928 Mr. Maxwell became Manager of the Estimating and Order Department. He was appointed Sales Manager in 1952, and General Sales Manager two years later. In 1955 came his appointment to the Board in the capacity of Deputy General Manager, and in 1959 Mr. Maxwell became General Manager of the Company which he had joined in such a humble position nearly half-a-century earlier.

REC 32 for further information





From drawing board to finished product

We are precision engineers in plastics creating up-to-the-minute mouldings for the trade. From first class designs come first class products and BODDINGTON'S reputation in this field.

This 'T' piece, made to special specifications for Bylock Electric Ltd., is the handle of an electric polisher. It carries two handle grips and is cored for cable and shaft independently. Provision has been made for cable cramp and switch insertion.

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LS products for the Electronics Industry

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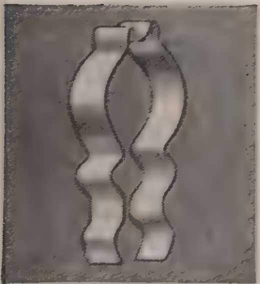
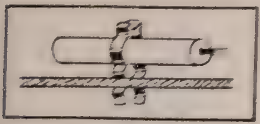


TRANSISTOR CLIPS

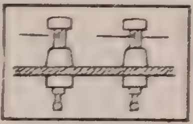
in Beryllium Copper

(Patent and Type Approval applied for)

Of compact design, and taking up no more room than the Transistor itself, these Clips, manufactured from Beryllium Copper and formed so as to assist heat dissipation, are designed to suit cylindrical Transistors such as the Mullard OC.72 for fixing horizontally to printed circuit boards.



Top illustration shows the clip greatly enlarged whilst the lower picture shows the clip actual size and also the method of fixing.



Pressure on the terminal cap opens the transverse hole and allows the wire or pin to be inserted. Release pressure and wire or pin is firmly held in position.

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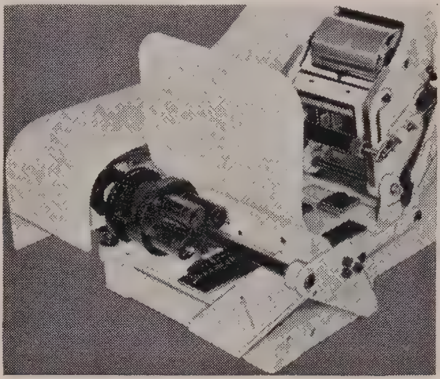

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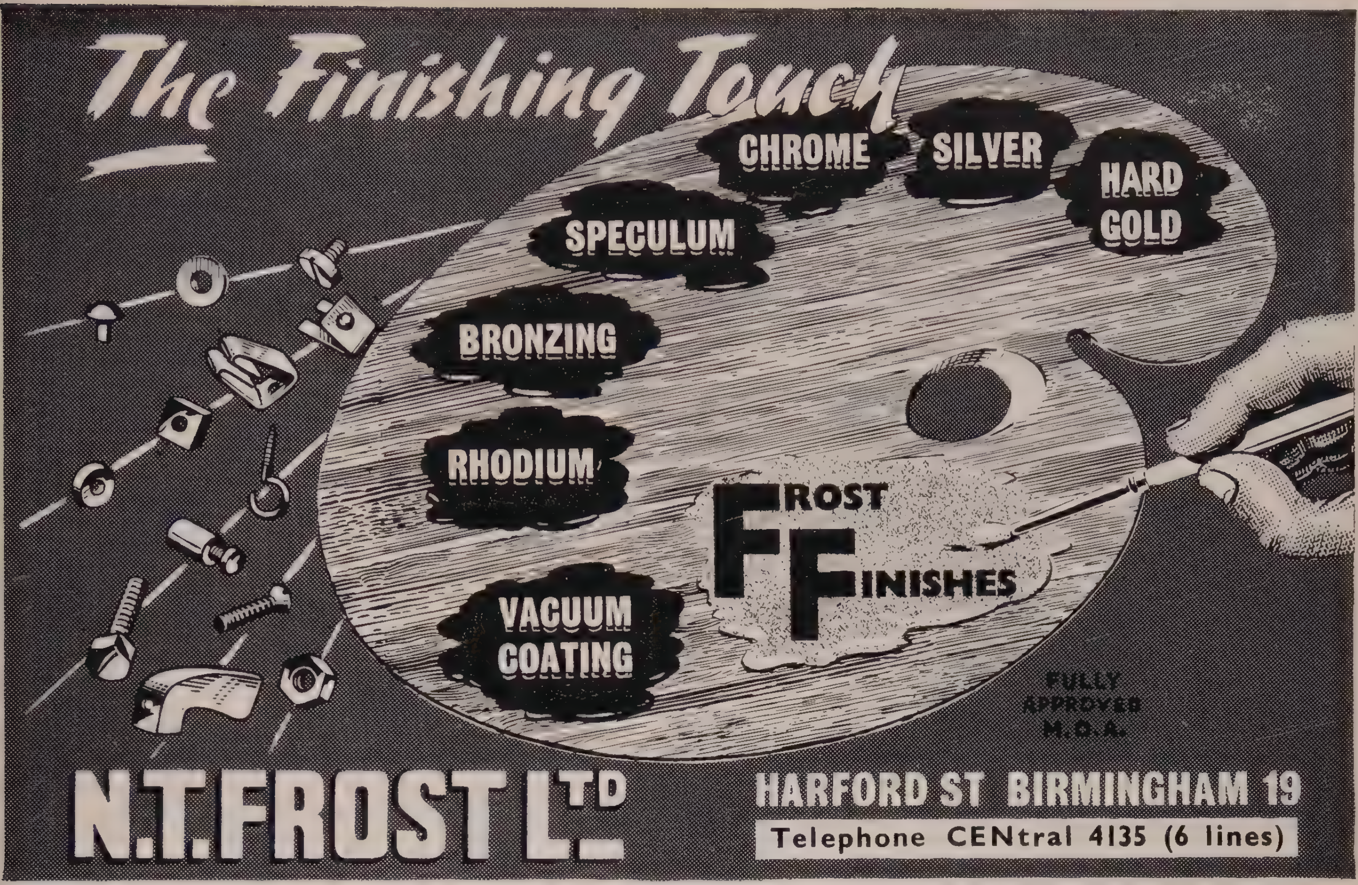

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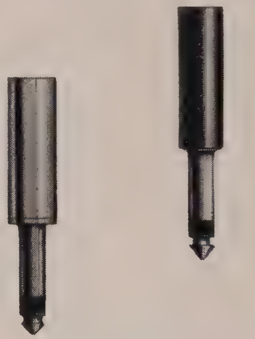

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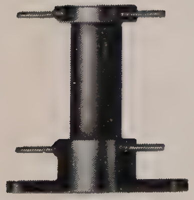
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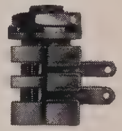

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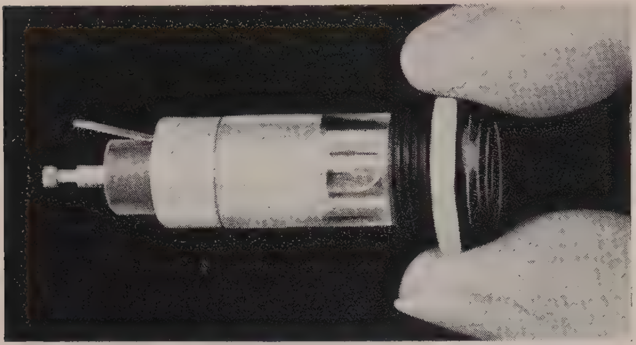

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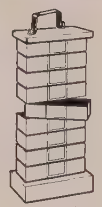

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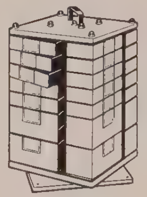

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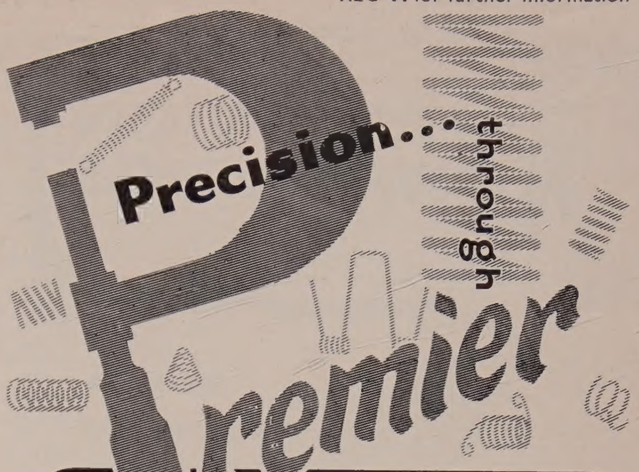

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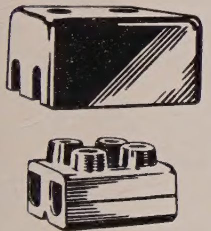

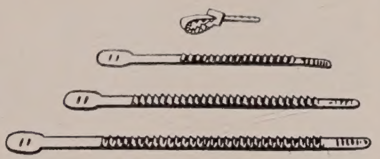

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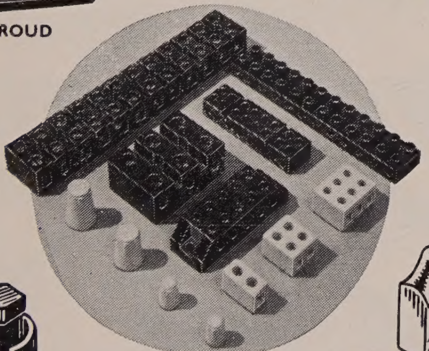

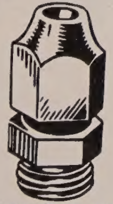

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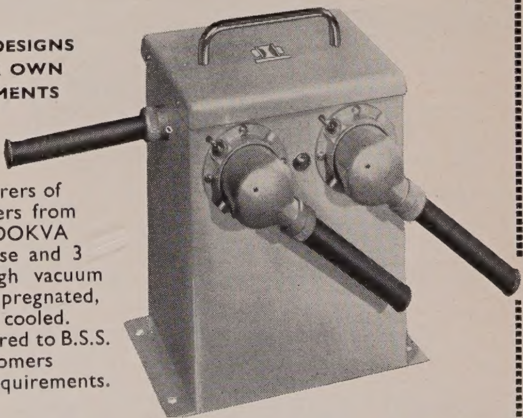

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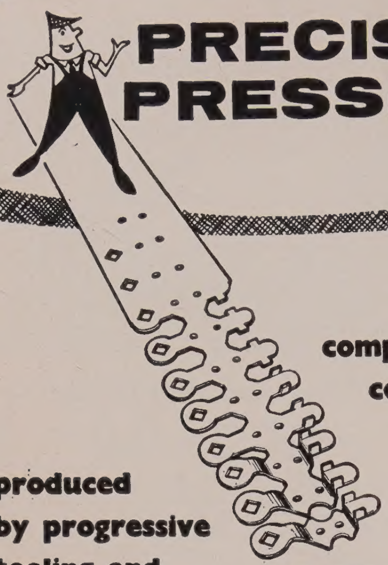

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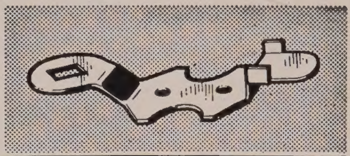

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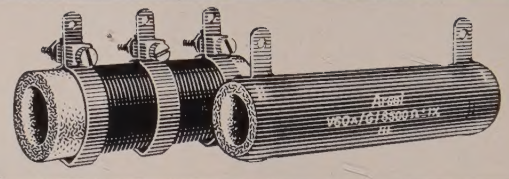

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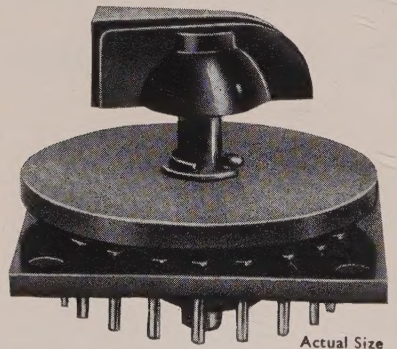

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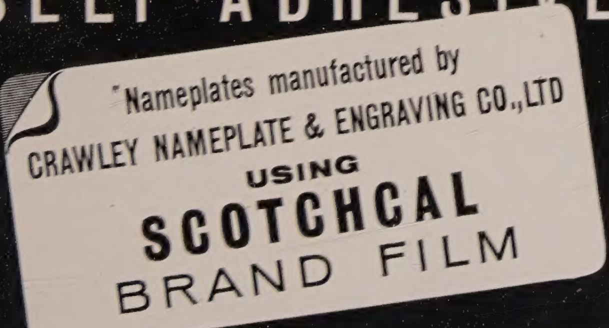
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INDEX TO ADVERTISERS

	Page
Adams Bros. & Burnley Ltd.	705
Aircraft-Marine Products (GB) Ltd.	627
Amphenol-Borg Ltd.	*August*
Ardente Acoustic Laboratories Ltd.	636
Ariel Pressings Ltd.	*August*
Ashburton Resistance Co. Ltd.	706
Atlas Plating Works Ltd.	707
Automatic Counting & Switching Equipments	704
Boddington, W. H., & Co. Ltd.	701
Bound Brook Bearings Ltd.	640
Bradley, G. & E., Ltd.	*Front Cover*
Brandauer, C., & Co. Ltd.	640
Britec Ltd.	632
Carr Fastener Co. Ltd.	*Inside Front Cover*
Classified Advertisements	707
Crawley Nameplate & Engraving Co. Ltd.	707
D.T.V. Group, The	*August*
Dartronic Ltd.	628
Davall Gear Co. Ltd., The	707
'Diamond H' Switches Ltd.	*July*
Duratube & Wire Ltd.	702
Egen Electric Ltd.	*July*
Electric Components	*July*
Evans, Frederick W., Ltd.	707
Farnell Instruments Ltd.	*August*
Filhol, J. P., Ltd.	*August*
Formica Ltd.	*August*
Forrest Transformers Ltd.	*August*
Frost, N. T., Ltd.	703
Goodyear Transformers Ltd.	705
Grelco Ltd.	638
Gresham Transformers Ltd.	*Back Cover*
Harwin Engineers Ltd.	693
Hassett & Harper Ltd.	*August*
Henley Burrowes & Co. Ltd.	706
Hewell Spring Co. Ltd.	702
Hughes International (U.K.) Ltd.	625
Imperial Chemical Industries Ltd.	622
Johnson, Matthey & Co. Ltd.	637
Jones & Barclay Ltd.	708
K.G.M. Electronics Ltd.	633
Lewis Spring Co. Ltd., The	701
Lorlin Electronics Co. Ltd.	630
Lucas, Joseph, Ltd.	*Front Cover*
Magnetic Devices Ltd.	623
Mallory Batteries Ltd.	635
Markem (UK) Ltd.	*August*
McMurdo Instrument Co. Ltd.	638
Metway Electrical Industries Ltd.	705
Modern Plastics Ltd.	702
Mycalex & T.I.M. Ltd.	*July*
N.S.F. Ltd.	629
Painton & Co. Ltd.	642
Parmeko Ltd.	*July*
Palmer, G. A. Stanley, Ltd.	632
Permacel Tapes Ltd.	*August*
Premier Spring Co. Ltd.	705
Pressac Ltd.	639
Rejafix Ltd.	702
Reliance Gear Co. Ltd.	*August*
Reliance Mfg. Co. (Southwark) Ltd.	634
Rendar Instruments Ltd.	703
Ross Courtney & Co. Ltd.	636
Round, B. J., & Sons Ltd.	708
Rundle, A., (Upper Norwood) Ltd.	707
Salford Electrical Instruments Ltd.	626
Salter, Geo., & Co. Ltd.	624
Sanders, H. G., & Son Ltd.	631
Sherwood Instruments Ltd.	706
Smallbone & Son Service Station Ltd.	704
Smith, John, Ltd.	706
Smith, S., & Sons (England) Ltd.	*Inside Back Cover*
Standard Telephones & Cables Ltd.	*August*
Suflex Ltd.	*August*
Teledictor Ltd.	*July*
Telephone Manufacturing Co. Ltd.	641-644
Tucker Eyelet, Geo., Co. Ltd.	*August*
Unbrako Socket Screw Co. Ltd.	686
United Trade Press Ltd.	704
Vitos Ltd.	626
Wallis Engineering Co. (Birmingham) Ltd.	*August*

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